PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 27 July 2000 (27.07.00)	
International application No. PCT/US99/28929	**Applicant's or agent's file reference** 00537-187WO1
International filing date (day/month/year) 07 December 1999 (07.12.99)	**Priority date** (day/month/year) 07 December 1998 (07.12.98)
Applicant DONG, Zheng, Xin et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

13 June 2000 (13.06.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Manu Berrod
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

YRT

by fax and post

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

TSAO, Y.Rocky
FISH & RICHARDSON P.C.
225 Franklin Street
Boston, Massachusetts 02110-2804
ETATS-UNIS D'AMERIQUE

FAX: 617 542 8906

RECEIVED PCT

FEB 21 2001

FISH & RICHARDSON, P.C.
BOSTON OFFICE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	15.02.2001
Applicant's or agent's file reference: 00537-187WO1	IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28929	07/12/1999	07/12/1998

Applicant: SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

* No Docketing Required *
Reviewed By Practice Systems
Initials:
Reviewed By Billing Secretary
Initials:

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Emslander, S Tel.+49 89 2399-8718

Form PCT/IPEA/416 (July 1992)

Sent TO BIOMEASURE 2/22

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
00537-187WO1		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28929	07/12/1999	07/12/1998
International Patent Classification (IPC) or national classification and IPC C07K14/605		
Applicant SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 10 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☒ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13/06/2000	15.02.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Moonen, P Telephone No. +49 89 2399 8538

Form PCT/IPEA/409 (cover sheet) (January 1994)

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 10-12.

because:

☒ the said international application, or the said claims Nos. 10-12 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination report cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:
   see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1, 7-12 in part.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	7-12 in part
	No:	Claims	1 in part
Inventive step (IS)	Yes:	Claims	
	No:	Claims	7-12 in part
Industrial applicability (IA)	Yes:	Claims	1, 7-9 in part
	No:	Claims	

2. Citations and explanations
   see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Reference is made to the following documents (D), cited partially in the Search Report:

D1: J Biol Chem 269 (1994) 6275-8 *
D2: J Endocrinol 159 (Oct 1998) 93-102 (only abstract) *
D3: J Pept Res 52 (Nov 1998) 398-409 *
D4: WO 91/11457
D5: EP 0 733 644
D6: WO 97/29180

The documents D1-D3 were not cited in the international search report. Copies of the documents have been supplied to the Applicant.

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. For the assessment of the present claims 10-12 on the question whether they are industrially applicable, no unified criteria exist in the PCT Contracting States. The patentability can also be dependent upon the formulation of the claims. The EPO, for example, does not recognize as industrially applicable the subject-matter of claims to the use of a compound in medical treatment, but may allow, however, claims to a known compound for first use in medical treatment and the use of such a compound for the manufacture of a medicament for a new medical treatment.

   Claims 10-12 relate to subject-matter considered by this Authority to be covered by the provisions of Rule 67.1(iv) PCT. Consequently, no opinion will be formulated with respect to the industrial applicability of the subject-matter of these claims (Article 34(4)(a)(i) PCT).

Re Item IV

Lack of unity of invention

2. Introduction: The provisos (i)-(vi) introduced into claim 1 indicate already that the prior art disclosed many different GLP-1 peptide analogues, also with respect to metabolic stability. Many of these analogues concerned different positions in the

compound of formula I having the native amino acid sequence of hGLP-1(7-36 or 7-37) with the terminal carboxyl group free or amidated (all A positions as defined in claim 1 taking the first specified residue, ie A^7 His, A^8 Ala, etc.): see proviso (i).

Proviso (ii) concerns a study in the prior art concerning single Ala replacement (see D1). D1 discloses a series of analogs of GLP-1 with each amino acid replaced with Ala (see Table I). Ala replacement is frequently applied in protein engineering as a first study to examine the importance of positions of residues in the polypeptide chain.

With respect to the other provisos, it is noted that originally filed provisos per se are fullfilling the requirements of the PCT. However, in view of Rule 5.1(a(ii) PCT, the applicant should also indicate in the description the background art which, as far as known to the applicant, can be regarded as useful for the understanding, searching and examination of the invention, and, preferably, cite the documents reflecting such art. At present, the basis for all provisos is not clear and is also not mentioned in the background of the invention. From **proviso (iv)(d)** it appears e.g. with respect to **position 7 (His)** that already several substitutions are known from the prior art.

3. Other studies also relate to analogs with improved stability: e.g. see D2 concerning a substitution at position 8. Structure-activity studies of GLP-1 have also been disclosed, referring to GLP-1 analogues: see D3, Table I. **D4 (and US-A-5,545,618)** refer to substitutions at positions **H7**, A8, E9, G10 D15, V16, S18, E21, G22, Q23, A24, K26, W31, K34 and R36 (see claim 1 and Figure 2). **D5** refers to substitutions at positions **H7**, A8, E21 and E27. D6 refers to substitutions at positions A8, E21, K26, E27.

4. The present International Examining Authority has identified at least 30 independent inventions in the present application as follows:
All specified modified positions A^7 (L-His) to position A^{36} (L-Arg) are considered to represent independent inventions (position A^{37} is well known to be either Gly or to be absent and therefore not presented as an independent invention).

5. With respect to the reasons for the observation of non-unity the following is noted:

The above cited studies in the prior art D1-D6 disclose all analogs of GLP-1: in particular reference is made to D1 allready referring to analogs for all specified positions.

A single general inventive concept (referred to in Rule 13 PCT and the PCT Preliminary Examination Guidelines Ch.III, 7) is therefore not recognisable in the absence of a common, special technical feature: the recognised independent inventions have only in common the fact that they refer to an analog of GLP-1, analogs of GLP-1 being well known.

6. The present International Examining Authority issued the invitation to restrict or to pay additional fees before further examination to be carried out. The Applicant decided not to reply to this invitation, and the **present IPER** is established for the **first mentioned invention (position A^7)**, thus **partially claims 1 and 7-12.**

It is noted that additional non-unitarily linked subject-matter is present within the presently examined invention: a unifying link is not recognised between the h-GLP-1's modified at position 7 as claimed in claim 7 or 8 on file:

[$Hppa^7$]hGLP-1(7-36)-NH_2 (SEQ ID NO: 87); Hppa is ?
[(Tma-His)^7]hGLP-1(7-36)-NH_2 (SEQ ID NO:117); Tma-His is N,N-tetramethylamidino-histidine;
[Ura^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 125); Ura is uroconic acid
[Paa^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 126); Paa is trans-3-(3-pyridyl) acrylic acid;
[Pta^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 127); Pta is (4-pyridylthio) acetic acid.

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

7. D3 has mentioned that position H7 is of primary importance for receptor binding (page 403 Table 2 and right column, and page 405 Figure 5 and discussion); reference is made to [Tyr^7]hGLP-1(7-36)-NH_2 and in the discussion to the GLP-1

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analogue with **His at position 7 removed** (see also reference 13; Suzuki et al.). This last analogue is **prejudicial** to the novelty of **claim 1** on file (Article 33(2) PCT). Finally, it is noted that with respect to [Tyr^7]hGLP-1(7-36)-NH_2, that a proviso may establish novelty, but is not suited for establishing the involvement of an inventive; the introduction of protecting groups at the N-termial amino group well known to the skilled person.

8. Some of the other documents refer also to substitution at position 7 to improve characteristics: see US-5,545,618, column 12, lines 50-55 and Tables 1-2; furthermore, D5 has referred to several analogues substituted at position 7: see claim 1.

At present it is considered in the absence of the demonstration of any special or advantaguous effects that the new substitutions of position 7 of hGLP-1(7-36/7) are obvous to the person skilled in the art. Therefore, the present application does not satisfy the criterion set forth in Article 33(3) PCT because the subject-matter of **claims 7-12** does not involve an inventive step (Rule 65(1)(2) PCT).

Re Item VI

Certain documents cited (Rule 70.10)

Certain published documents (Rule 70.10)

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
EP-A-0 955 314 =FR-A-2 777 283	10.11.99	12.03.99	10.04.98

Re Item VII

Certain defects in the international application

9. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D3-D5 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

10. In conjunction with the above observation with respect to the lack of unity of invention, it is noted that Article 6 of the PCT requires that all independent claims contain the essential technical feature(s) of the invention (see also Rule 6.3(a) PCT).

    At present the special **technical** feature of the invention, present in all independent claims on file, is not recognised: it is not been proven that **all** the claimed GLP-1 analogs as claimed have the **functional** feature of improved property.

11. The document cited in the International Search Report as "P,X-document" will not be considered as the priority documents are (almost) identical to the international application .

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PATENT COOPERATION TREA[illegible]

4RT

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
FISH & RICHARDSON P.C.
Attn. TSAO, Y.Rocky
225 Franklin Street
Boston, Massachusetts 02110-2804
UNITED STATES OF AMERICA

RECEIVED
MAY 22 2000
FISH & RICHARDSON, P.C.
BOSTON OFFICE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 00537-187W01	Date of mailing (day/month/year) 15/05/2000
International application No. PCT/US 99/ 28929	FOR FURTHER ACTION See paragraphs 1 and 4 below
Applicant SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...	International filing date (day/month/year) 07/12/1999

Docketed By Billing Secretary
Due Date:
Deadline:
Initials:

1. [X] The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Fascimile No.: (41-22) 740.14.35

Docketed By Practice Systems
RESP TO RPT 7/15/00
Initials: LXA

For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Nina Vercio

Form PCT/ISA/220 (July 1998)

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international pbulication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped),whether

(i) the claim is unchanged;

(ii) the claim is cancelled;

(iii) the claim is new;

(iv) the claim replaces one or more claims as filed;

(v) the claim is the result of the division of a claim as filed.

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."

2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."

3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."

4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

It must be in the language in which the international appplication is to be published.

It must be brief, not exceeding 500 words if in English or if translated into English.

It should not be confused with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It may not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

Consequence if a demand for international preliminary examination has already been filed

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
00537-187W01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 99/ 28929	07/12/1999	07/12/1998

Applicant

SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [X] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

[ ] the text is approved as submitted by the applicant.

[X] the text has been established by this Authority to read as follows:

GLP-1 ANALOGUES

5. With regard to the **abstract**,

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. —

[ ] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/ 28929

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Remark: Although claims 10-12 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/28929

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07K14/605 A61K38/26 A61P3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07K A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91 11457 A (BUCKLEY DOUGLAS I ;HABENER JOEL F (US); MALLORY JOANNE B (US); MOJ) 8 August 1991 (1991-08-08) claims; examples	1,2,9-12
X	EP 0 733 644 A (LILLY CO ELI) 25 September 1996 (1996-09-25) page 3, line 51 -page 4, line 1; claims; examples	1,2,9-12
X	WO 97 29180 A (BRODERICK CAROL L ;BORTS TRACY L (US); MILLER ANNE R (US); LILLY C) 14 August 1997 (1997-08-14) claims; examples	1,2,9-12
X	US 5 545 618 A (BUCKLEY DOUGLAS I ET AL) 13 August 1996 (1996-08-13) claims; figures 1,2A; examples	1,2,9-12

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2000	15/05/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Fuhr, C

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	FR 2 777 283 A (ADIR) 15 October 1999 (1999-10-15) page 2, line 10 -page 6, line 3; claims; examples	1,2,9-12
A	WO 98 08871 A (NOVONORDISK AS ;KNUDSEN LISELOTTE BJERRE (DK); NIELSEN PER FRANKLI) 5 March 1998 (1998-03-05) claims; examples	1,9-12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/28929

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Although claims 10-12 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9111457 A	08-08-1991	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		US 5545618 A	13-08-1996
EP 0733644 A	25-09-1996	US 5705483 A	06-01-1998
		AU 708159 B	29-07-1999
		AU 2026895 A	03-10-1996
		BR 9503036 A	23-09-1997
		CA 2150080 A	22-09-1996
		CN 1131674 A	25-09-1996
		CZ 9501321 A	16-10-1996
		FI 952536 A	22-09-1996
		HU 74729 A	28-02-1997
		JP 8269097 A	15-10-1996
		NO 952034 A	23-09-1996
		NZ 272186 A	29-01-1997
		PL 308783 A	30-09-1996
		US 5977071 A	02-11-1999
		ZA 9504141 A	22-11-1996
WO 9729180 A	14-08-1997	AU 2263197 A	28-08-1997
		CA 2243718 A	14-08-1997
		EP 0879279 A	25-11-1998
US 5545618 A	13-08-1996	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		WO 9111457 A	08-08-1991
FR 2777283 A	15-10-1999	AU 2368899 A	21-10-1999
		CN 1232038 A	20-10-1999
		EP 0955314 A	10-11-1999
		HU 9900604 A	28-09-1999
		JP 11310597 A	09-11-1999
		NO 991199 A	11-10-1999
		NZ 334379 A	28-10-1999
		PL 331960 A	11-10-1999
WO 9808871 A	05-03-1998	AU 3847897 A	19-03-1998
		AU 4112497 A	19-03-1998
		CN 1232470 A	20-10-1999
		CZ 9900629 A	14-07-1999
		WO 9808872 A	05-03-1998
		EP 0944648 A	29-09-1999
		EP 0929576 A	21-07-1999
		JP 2000500505 T	18-01-2000
		NO 990950 A	28-04-1999
		PL 331896 A	16-08-1999

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
00537-187WO1		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/28929	07/12/1999	07/12/1998
International Patent Classification (IPC) or national classification and IPC C07K14/605		
Applicant SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 10 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
VI	☒	Certain documents cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13/06/2000	15.02.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Moonen, P Telephone No. +49 89 2399 8538

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/28929

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-28 as originally filed

Claims, No.:

1-12 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 10-12.

because:

☒ the said international application, or the said claims Nos. 10-12 relate to the following subject matter which does not require an international preliminary examination (*specify*):
see separate sheet

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination report cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:
   see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☐ all parts.

   ☒ the parts relating to claims Nos. 1, 7-12 in part.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	7-12 in part
	No:	Claims	1 in part
Inventive step (IS)	Yes:	Claims	
	No:	Claims	7-12 in part
Industrial applicability (IA)	Yes:	Claims	1, 7-9 in part
	No:	Claims	

2. Citations and explanations
   see separate sheet

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Reference is made to the following documents (D), cited partially in the Search Report:

D1: J Biol Chem 269 (1994) 6275-8 *
D2: J Endocrinol 159 (Oct 1998) 93-102 (only abstract) *
D3: J Pept Res 52 (Nov 1998) 398-409 *
D4: WO 91/11457
D5: EP 0 733 644
D6: WO 97/29180

The documents D1-D3 were not cited in the international search report. Copies of the documents have been supplied to the Applicant.

Re Item III

Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. For the assessment of the present claims 10-12 on the question whether they are industrially applicable, no unified criteria exist in the PCT Contracting States. The patentability can also be dependent upon the formulation of the claims. The EPO, for example, does not recognize as industrially applicable the subject-matter of claims to the use of a compound in medical treatment, but may allow, however, claims to a known compound for first use in medical treatment and the use of such a compound for the manufacture of a medicament for a new medical treatment.

   Claims 10-12 relate to subject-matter considered by this Authority to be covered by the provisions of Rule 67.1(iv) PCT. Consequently, no opinion will be formulated with respect to the industrial applicability of the subject-matter of these claims (Article 34(4)(a)(i) PCT).

Re Item IV

Lack of unity of invention

2. Introduction: The provisos (i)-(vi) introduced into claim 1 indicate already that the prior art disclosed many different GLP-1 peptide analogues, also with respect to metabolic stability. Many of these analogues concerned different positions in the

compound of formula I having the native amino acid sequence of hGLP-1(7-36 or 7-37) with the terminal carboxyl group free or amidated (all A positions as defined in claim 1 taking the first specified residue, ie A^7 His, A^8 Ala, etc.): see proviso (i).

Proviso (ii) concerns a study in the prior art concerning single Ala replacement (see D1). D1 discloses a series of analogs of GLP-1 with each amino acid replaced with Ala (see Table I). Ala replacement is frequently applied in protein engineering as a first study to examine the importance of positions of residues in the polypeptide chain.

With respect to the other provisos, it is noted that originally filed provisos per se are fullfilling the requirements of the PCT. However, in view of Rule 5.1(a(ii) PCT, the applicant should also indicate in the description the background art which, as far as known to the applicant, can be regarded as useful for the understanding, searching and examination of the invention, and, preferably, cite the documents reflecting such art. At present, the basis for all provisos is not clear and is also not mentioned in the background of the invention. From **proviso (iv)(d)** it appears e.g. with respect to **position 7 (His)** that already several substitutions are known from the prior art.

3. Other studies also relate to analogs with improved stability: e.g. see D2 concerning a substitution at position 8. Structure-activity studies of GLP-1 have also been disclosed, referring to GLP-1 analogues: see D3, Table I. **D4 (and US-A-5,545,618)** refer to substitutions at positions **H7**, A8, E9, G10 D15, V16, S18, E21, G22, Q23, A24, K26, W31, K34 and R36 (see claim 1 and Figure 2). **D5** refers to substitutions at positions **H7**, A8, E21 and E27. D6 refers to substitutions at positions A8, E21, K26, E27.

4. The present International Examining Authority has identified at least 30 independent inventions in the present application as follows:
All specified modified positions A^7 (L-His) to position A^{36} (L-Arg) are considered to represent independent inventions (position A^{37} is well known to be either Gly or to be absent and therefore not presented as an independent invention).

5. With respect to the reasons for the observation of non-unity the following is noted:

The above cited studies in the prior art D1-D6 disclose all analogs of GLP-1: in particular reference is made to D1 allready referring to analogs for all specified positions.

A single general inventive concept (referred to in Rule 13 PCT and the PCT Preliminary Examination Guidelines Ch.III, 7) is therefore not recognisable in the absence of a common, special technical feature: the recognised independent inventions have only in common the fact that they refer to an analog of GLP-1, analogs of GLP-1 being well known.

6. The present International Examining Authority issued the invitation to restrict or to pay additional fees before further examination to be carried out. The Applicant decided not to reply to this invitation, and the **present IPER** is established for the **first mentioned invention (position A^7)**, thus **partially claims 1 and 7-12.**

It is noted that additional non-unitarily linked subject-matter is present within the presently examined invention: a unifying link is not recognised between the h-GLP-1's modified at position 7 as claimed in claim 7 or 8 on file:

[$Hppa^7$]hGLP-1(7-36)-NH_2 (SEQ ID NO: 87); Hppa is ?
[(Tma-His)^7]hGLP-1(7-36)-NH_2 (SEQ ID NO:117); Tma-His is N,N-tetramethylamidino-histidine;
[Ura^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 125); Ura is uroconic acid
[Paa^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 126); Paa is trans-3-(3-pyridyl) acrylic acid;
[Pta^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 127); Pta is (4-pyridylthio) acetic acid.

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

7. D3 has mentioned that position H7 is of primary importance for receptor binding (page 403 Table 2 and right column, and page 405 Figure 5 and discussion); reference is made to [Tyr^7]hGLP-1(7-36)-NH_2 and in the discussion to the GLP-1

analogue with **His at position 7 removed** (see also reference 13; Suzuki et al.). This last analogue is **prejudicial** to the novelty of **claim 1** on file (Article 33(2) PCT). Finally, it is noted that with respect to [Tyr^7]hGLP-1(7-36)-NH_2, that a proviso may establish novelty, but is not suited for establishing the involvement of an inventive; the introduction of protecting groups at the N-termial amino group well known to the skilled person.

8. Some of the other documents refer also to substitution at position 7 to improve characteristics: see US-5,545,618, column 12, lines 50-55 and Tables 1-2; furthermore, D5 has referred to several analogues substituted at position 7: see claim 1.

At present it is considered in the absence of the demonstration of any special or advantaguous effects that the new substitutions of position 7 of hGLP-1(7-36/7) are obvous to the person skilled in the art. Therefore, the present application does not satisfy the criterion set forth in Article 33(3) PCT because the subject-matter of **claims 7-12** does not involve an inventive step (Rule 65(1)(2) PCT).

Re Item VI

Certain documents cited (Rule 70.10)

Certain published documents (Rule 70.10)

Application No Patent No	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date *(valid claim)* *(day/month/year)*
EP-A-0 955 314 =FR-A-2 777 283	10.11.99	12.03.99	10.04.98

Re Item VII

Certain defects in the international application

9. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the documents D1, D3-D5 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

10. In conjunction with the above observation with respect to the lack of unity of invention, it is noted that Article 6 of the PCT requires that all independent claims contain the essential technical feature(s) of the invention (see also Rule 6.3(a) PCT).

    At present the special **technical** feature of the invention, present in all independent claims on file, is not recognised: it is not been proven that **all** the claimed GLP-1 analogs as claimed have the **functional** feature of improved property.

11. The document cited in the International Search Report as "P,X-document" will not be considered as the priority documents are (almost) identical to the international application .

****

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
00537-187W01		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 99/ 28929	07/12/1999	07/12/1998
Applicant		
SOCIETE DE CONSEILS DE RECHERCHES ET D'APPLICA...		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [X] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   GLP-1 ANALOGUES

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. --

   [ ] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/28929

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Remark: Although claims 10-12 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No
US 99/28929

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07K14/605 A61K38/26 A61P3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07K A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91 11457 A (BUCKLEY DOUGLAS I ;HABENER JOEL F (US); MALLORY JOANNE B (US); MOJ) 8 August 1991 (1991-08-08) claims; examples	1,2,9-12
X	EP 0 733 644 A (LILLY CO ELI) 25 September 1996 (1996-09-25) page 3, line 51 -page 4, line 1; claims; examples	1,2,9-12
X	WO 97 29180 A (BRODERICK CAROL L ;BORTS TRACY L (US); MILLER ANNE R (US); LILLY C) 14 August 1997 (1997-08-14) claims; examples	1,2,9-12
X	US 5 545 618 A (BUCKLEY DOUGLAS I ET AL) 13 August 1996 (1996-08-13) claims; figures 1,2A; examples	1,2,9-12

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[X] Further documents are listed in the continuation of box C.

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
P,X	FR 2 777 283 A (ADIR) 15 October 1999 (1999-10-15) page 2, line 10 -page 6, line 3; claims; examples	1,2,9-12
A	WO 98 08871 A (NOVONORDISK AS ;KNUDSEN LISELOTTE BJERRE (DK); NIELSEN PER FRANKLI) 5 March 1998 (1998-03-05) claims; examples	1,9-12

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9111457 A	08-08-1991	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		US 5545618 A	13-08-1996
EP 0733644 A	25-09-1996	US 5705483 A	06-01-1998
		AU 708159 B	29-07-1999
		AU 2026895 A	03-10-1996
		BR 9503036 A	23-09-1997
		CA 2150080 A	22-09-1996
		CN 1131674 A	25-09-1996
		CZ 9501321 A	16-10-1996
		FI 952536 A	22-09-1996
		HU 74729 A	28-02-1997
		JP 8269097 A	15-10-1996
		NO 952034 A	23-09-1996
		NZ 272186 A	29-01-1997
		PL 308783 A	30-09-1996
		US 5977071 A	02-11-1999
		ZA 9504141 A	22-11-1996
WO 9729180 A	14-08-1997	AU 2263197 A	28-08-1997
		CA 2243718 A	14-08-1997
		EP 0879279 A	25-11-1998
US 5545618 A	13-08-1996	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		WO 9111457 A	08-08-1991
FR 2777283 A	15-10-1999	AU 2368899 A	21-10-1999
		CN 1232038 A	20-10-1999
		EP 0955314 A	10-11-1999
		HU 9900604 A	28-09-1999
		JP 11310597 A	09-11-1999
		NO 991199 A	11-10-1999
		NZ 334379 A	28-10-1999
		PL 331960 A	11-10-1999
WO 9808871 A	05-03-1998	AU 3847897 A	19-03-1998
		AU 4112497 A	19-03-1998
		CN 1232470 A	20-10-1999
		CZ 9900629 A	14-07-1999
		WO 9808872 A	05-03-1998
		EP 0944648 A	29-09-1999
		EP 0929576 A	21-07-1999
		JP 2000500505 T	18-01-2000
		NO 990950 A	28-04-1999
		PL 331896 A	16-08-1999

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(54) Title: GLP–1 ANALOGUES

(57) Abstract

The present invention is directed to peptide analogues of glucagon–like peptide–1, the pharmaceutically–acceptable salts thereof, to methods of using such analogues to treat mammals and to pharmaceutical compositions useful therefor comprising said analogues.

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GLP-1 ANALOGUES

Background of the Invention

The present invention is directed to peptide analogues of glucagon-like peptide-1, the pharmaceutically-acceptable salts thereof, to methods of using such analogues to treat mammals and to pharmaceutical compositions useful therefor comprising said analogues.

Glucagon-like peptide-1 (7-36) amide (GLP-1) (SEQ ID NO: 1) is synthesized in the intestinal L-cells by tissue-specific post-translational processing of the glucagon precursor pre-proglucagon (Varndell, J.M., et al., J. Histochem Cytochem, 1985:33:1080-6) and is released into the circulation in response to a meal. The plasma concentration of GLP-1 rises from a fasting level of approximately 15 pmol/L to a peak postprandial level of 40 pmol/L. It has been demonstrated that, for a given rise in plasma glucose concentration, the increase in plasma insulin is approximately threefold greater when glucose is administered orally compared with intravenously (Kreymann, B., et al., Lancet 1987:2, 1300-4). This alimentary enhancement of insulin release, known as the incretin effect, is primarily humoral and GLP-1 is now thought to be the most potent physiological incretin in humans. In addition to the insulinotropic effect, GLP-1 suppresses glucagon secretion, delays gastric emptying (Wettergren A., et al., Dig Dis Sci 1993:38:665-73) and may enhance peripheral glucose disposal (D'Alessio, D.A. et al., J. Clin Invest 1994:93:2293-6).

In 1994, the therapeutic potential of GLP-1 was suggested following the observation that a single subcutaneous (s/c) dose of GLP-1 could completely normalize postprandial glucose levels in patients with non-insulin-dependent diabetes mellitus (NIDDM) (Gutniak, M.K., et al., Diabetes Care 1994:17:1039-44). This effect was thought to be mediated both by increased insulin release and by a reduction in glucagon secretion. Furthermore, an intravenous infusion of GLP-1 has been shown to delay postprandial gastric emptying in patients with NIDDM (Williams, B., et al., J. Clin Endo Metab 1996:81:327-32). Unlike sulfonylureas, the insulinotropic action of GLP-1 is dependent on plasma glucose concentration (Holz, G.G. 4th, et al., Nature 1993:361:362-5). Thus, the loss of GLP-1-mediated insulin release at low plasma glucose concentration protects against severe hypoglycemia.

This combination of actions gives GLP-1 unique potential therapeutic advantages over other agents currently used to treat NIDDM.

Numerous studies have shown that when given to healthy subjects, GLP-1 potently influences glycemic levels as well as insulin and glucagon concentrations (Orskov, C, Diabetologia 35:701-711, 1992; Holst, J.J., et al., Potential of GLP-1 in diabetes management in Glucagon III, Handbook of Experimental Pharmacology, Lefevbre PJ, Ed. Berlin, Springer Verlag, 1996, p. 311-326), effects which are glucose dependent (Kreymann, B., et al., Lancet ii: 1300-1304, 1987; Weir, G.C., et al., Diabetes 38:338-342, 1989). Moreover, it is also effective in patients with diabetes (Gutniak, M., N. Engl J Med 226:1316-1322, 1992; Nathan, D.M., et al., Diabetes Care 15:270-276, 1992), normalizing blood glucose levels in type 2 diabetic subjects (Nauck, M.A., et al., Diagbetologia 36:741-744, 1993), and improving glycemic control in type 1 patients (Creutzfeldt, W.O., et al., Diabetes Care 19:580-586, 1996), raising the possibility of its use as a therapeutic agent.

GLP-1 is, however, metabolically unstable, having a plasma half-life ($t_{1/2}$) of only 1-2 min *in vivo*. Exogonously administered GLP-1 is also rapidly degraded (Deacon, C.F., et al., Diabetes 44:1126-1131, 1995). This metabolic instability limits the therapeutic potential of native GLP-1. Hence, there is a need for GLP-1 analogues that are more active or are more metabolically stable than native GLP-1.

Summary of the Invention

In one aspect, the present invention is directed to a compound of formula (I), (R^2R^3)- A^7 -A^8 -A^9 -A^{10} -A^{11} -A^{12} -A^{13} -A^{14} -A^{15} -A^{16} -A^{17} -A^{18} -A^{19} -A^{20} -A^{21} -A^{22} -A^{23} -A^{24} -A^{25} -A^{26} -A^{27} -A^{28} -A^{29} -A^{30} -A^{31} -A^{32} -A^{33} -A^{34} -A^{35} -A^{36} –A^{37}- R^1 ,

(I)

wherein

A^7 is L-His, Ura, Paa, Pta, D-His, Tyr, 3-Pal, 4-Pal, Hppa, Tma-His, Amp or deleted, provided that when A^7 is Ura, Paa, Pta or Hppa then R^2 and R^3 are deleted;

A^8 is Ala, D-Ala, Aib, Acc, N-Me-Ala, N-Me-D-Ala, Arg or N-Me-Gly;

A^9 is Glu, N-Me-Glu, N-Me-Asp or Asp;

A^{10} is Gly, Acc, Ala, D-Ala, Phe or Aib;

A^{11} is Thr or Ser;

A^{12} is Phe, Acc, Aic, Aib, 3-Pal, 4-Pal, β-Nal, Cha, Trp or X^1-Phe;

A^{13} is Thr or Ser;

A^{14} is Ser, Thr, Ala or Aib;

A^{15} is Asp, Ala, D-Asp or Glu;

A^{16} is Val, D-Val, Acc, Aib, Leu, Ile, Tle, Nle, Abu, Ala, D-Ala, Tba or Cha;

A^{17} is Ser, Ala, D-Ala, Aib, Acc or Thr;

A^{18} is Ser, Ala, D-Ala, Aib, Acc or Thr;

A^{19} is Tyr, D-Tyr, Cha, Phe, 3-Pal, 4-Pal, Acc, β-Nal, Amp or X^1-Phe;

A^{20} is Leu, Ala, Acc, Aib, Nle, Ile, Cha, Tle, Val, Phe or X^1-Phe;

A^{21} is Glu, Ala or Asp;

A^{22} is Gly, Acc, Ala, D-Ala, β-Ala or Aib;

A^{23} is Gln, Asp, Ala, D-Ala, Aib, Acc, Asn or Glu;

A^{24} is Ala, Aib, Val, Abu, Tle or Acc;

A^{25} is Ala, Aib, Val, Abu, Tle, Acc, Lys, Arg, hArg, Orn, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O) or HN-CH($(CH_2)_e$-X^3)-C(O);

A^{26} is Lys, Ala, 3-Pal, 4-Pal, Arg, hArg, Orn, Amp, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O) or HN-CH($(CH_2)_e$-X^3)-C(O);

A^{27} is Glu, Ala, D-Ala or Asp;

A^{28} is Phe, Ala, Pal, β-Nal, X^1-Phe, Aic, Acc, Aib, Cha or Trp;

A^{29} is Ile, Acc, Aib, Leu, Nle, Cha, Tle, Val, Abu, Ala, Tba or Phe;

A^{30} is Ala, Aib, Acc or deleted;

A^{31} is Trp, Ala, β-Nal, 3-Pal, 4-Pal, Phe, Acc, Aib, Cha, Amp or deleted;

A^{32} is Leu, Ala, Acc, Aib, Nle, Ile, Cha, Tle, Phe, X^1-Phe, Ala or deleted;

A^{33} is Val, Acc, Aib, Leu, Ile, Tle, Nle, Cha, Ala, Phe, Abu, X^1-Phe, Tba, Gaba or deleted;

A^{34} is Lys, Arg, hArg, Orn, Amp, Gaba, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O), HN-CH($(CH_2)_e$-X^3)-C(O) or deleted;

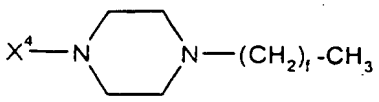
A^{35} is Gly or deleted;

A^{36} is L- or D-Arg, D- or L-Lys, D- or L-hArg, D- or L-Orn, Amp, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O), HN-CH($(CH_2)_e$-X^3)-C(O) or deleted;

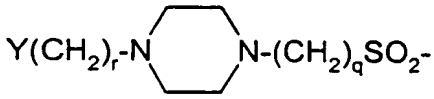
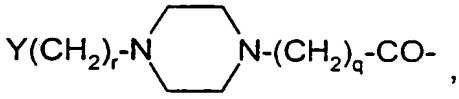
A^{37} is Gly or deleted;

X^1 for each occurrence is independently selected from the group consisting of (C_1-C_6)alkyl, OH and halo;

R^1 is OH, NH_2, (C_1-C_{12})alkoxy, or NH-X^2-CH_2-Z^0, wherein X^2 is a (C_1-C_{12})hydrocarbon moiety, and Z^0 is H, OH, CO_2H or $CONH_2$;

X^3 is  or $-C(O)-NHR^{12}$, wherein X^4 for each occurrence is independently -C(O)-, -NH-C(O)- or $-CH_2-$, and f for each occurrence is independently an integer from 1 to 29;

each of R^2 and R^3 is independently selected from the group consisting of H, (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, phenyl(C_1-C_{30})alkyl, naphthyl(C_1-C_{30})alkyl, hydroxy(C_1-C_{30})alkyl, hydroxy(C_2-C_{30})alkenyl, hydroxyphenyl(C_1-C_{30})alkyl, and hydroxynaphthyl(C_1-C_{30})alkyl; or one of R^2 and R^3 is $C(O)X^5$ in which X^5 is (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, phenyl(C_1-C_{30})alkyl, naphthyl(C_1-C_{30})alkyl, hydroxy(C_1-C_{30})alkyl, hydroxy(C_2-C_{30})alkenyl, hydroxyphenyl(C_1-C_{30})alkyl, hydroxynaphthyl(C_1-C_{30})alkyl,  ,

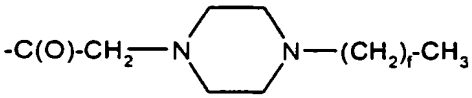
 or  ,

(a) (b)

where Y is H or OH, r is 0-4 and q is 0-4;

n for each occurrence is independently an integer from 1-5; and

R^{10} and R^{11} for each occurrence is each independently H, (C_1-C_{30})alkyl, (C_1-C_{30})acyl, (C_1-C_{30})alkylsulfonyl, $-C((NH)(NH_2))$ or

 , provided that when R^{10} is (C_1-C_{30})acyl,  , (C_1-C_{30})alkylsulfonyl, $-C((NH)(NH_2))$ or

R^{11} is H or (C_1-C_{30})alkyl; and

R^{12} is (C_1-C_{30})alkyl;

with the proviso that:

(i) at least one amino acid of a compound of formula (I) is not the same as the native sequence of hGLP-1(7-36, or -37)NH_2 (SEQ ID NOS: 1, 2) or hGLP-1(7-36, or -37)OH (SEQ ID NOS: 3, 4);

(ii) a compound of formula (I) is not an analogue of hGLP-1(7-36, or -37)NH_2 (SEQ ID NOS: 1, 2) or hGLP-1(7-36, or -37)OH (SEQ ID NOS: 3, 4) wherein a single position has been substituted by Ala;

(iii) a compound of formula (I) is not [Lys^{26}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 5-8), [Lys^{34}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 9-12), [$Lys^{26,34}$-bis(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 13-16), [Arg^{26}, Lys^{34}(N^{ε}-alkanoyl)]hGLP-1(8-36, or -37)-E (SEQ ID NOS: 17-20), or [$Arg^{26,34}$, Lys^{36}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E, wherein E is -OH or -NH_2 (SEQ ID NOS: 21-24);

(iv) a compound of formula (I) is not Z^1-hGLP-1(7-36, or -37)-OH, Z^1-hGLP-1(7-36, or -37)-NH_2, where Z^1 is selected from the group consisting of

(a) [Arg^{26}] (SEQ ID NOS: 25-28), [Arg^{34}] (SEQ ID NOS: 29-32), [$Arg^{26,34}$] (SEQ ID NOS: 33-36), [Lys^{36}] (SEQ ID NOS: 37-40), [Arg^{26}, Lys^{36}] (SEQ ID NOS: 41-44), [Arg^{34}, Lys^{36}] (SEQ ID NOS: 45-48), [D-Lys^{36}], [Arg^{36}] (SEQ ID NOS: 3,4,1,2), [D-Arg^{36}], [$Arg^{26,34}$, Lys^{36}] (SEQ ID NOS: 49-52), or [$Arg^{26,36}$, Lys^{34}] (SEQ ID NOS: 25-28);

(b) [Asp^{21}] (SEQ ID NOS: 53-56);

(c) at least one of [Aib^8] (SEQ ID NOS: 57-60), [D-Ala^8] and [Asp^9] (SEQ ID NOS: 61-64); and

(d) [Tyr^7] (SEQ ID NOS: 65-68), [N-acyl-His^7] (SEQ ID NOS: 69-72), [N-alkyl-His^7], [N-acyl-D-His^7] (SEQ ID NOS: 73-76) or [N-alkyl-D-His^7];

(v) a compound of formula (I) is not a combination of any two of the substitutions listed in groups (a) to (d); and

(vi) a compound of formula (I) is not [N-Me-Ala^8]hGLP-1(8-36 or -37) (SEQ ID NOS: 75, 78), [Glu^{15}]hGLP-1(7-36 or -37) (SEQ ID NOS: 79, 80), [Asp^{21}]hGLP-1(7-36 or -37) (SEQ ID NOS: 53, 54)or [Phe^{31}]hGLP-1(7-36 or -37) (SEQ ID NOS: 81, 82).

A preferred compound of the immediately foregoing compound of formula (I) is where A^{11} is Thr; A^{13} is Thr; A^{14} is Ser, Aib or Ala; A^{17} is Ser, Ala, Aib or D-Ala; A^{18} is Ser, Ala, Aib or D-Ala; A^{21} is Glu or Ala; A^{23} is Gln, Glu, or Ala; and A^{27} is Glu or Ala; or a pharmaceutically acceptable salt thereof.

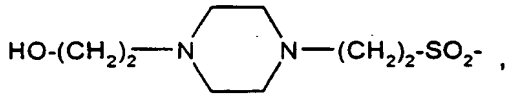
A preferred compound of the immediately foregoing compound of formula (I) is where A^9 is Glu, N-Me-Glu or N-Me-Asp; A^{12} is Phe, Acc or Aic; A^{16} is Val, D-Val, Acc, Aib, Ala, Tle or D-Ala; A^{19} is Tyr, 3-Pal, 4-Pal or D-Tyr; A^{20} is Leu, Acc, Cha, Ala or Tle; A^{24} is Ala, Aib or Acc; A^{25} is Ala, Aib, Acc, Lys, Arg, hArg, Orn, HN-

$CH((CH_2)_n\text{-}NH\text{-}R^{10})\text{-}C(O)$; A^{28} is Phe or Ala; A^{29} is Ile, Acc or Tle; A^{30} is Ala, Aib or deleted; A^{31} is Trp, Ala, 3-Pal, 4-Pal or deleted; A^{32} is Leu, Acc, Cha, Ala or deleted; A^{33} is Val, Acc, Ala, Gaba, Tle or deleted; or a pharmaceutically acceptable salt thereof.

A preferred compound of the immediately foregoing compound of formula (I) is where A^8 is Ala, D-Ala, Aib, A6c, A5c, N-Me-Ala, N-Me-D-Ala or N-Me-Gly; A^{10} is Gly, Ala, D-Ala or Phe; A^{12} is Phe, A6c or A5c; A^{16} is Val, Ala, Tle, A6c, A5c or D-Val; A^{20} is Leu, A6c, A5c, Cha, Ala or Tle; A^{22} is Gly, Aib, β-Ala, L-Ala or D-Ala; A^{24} is Ala or Aib; A^{29} is Ile, A6c, A5c or Tle; A^{32} is Leu, A6c, A5c, Cha, Ala or deleted; A^{33} is Val, A6c, A5c, Ala, Gaba, Tle or deleted; or a pharmaceutically acceptable salt thereof.

A preferred compound of the immediately foregoing compound of formula (I) is where R^1 is OH or NH_2 or a pharmaceutically acceptable salt thereof.

A preferred compound of the immediately foregoing compound of formula (I) or a pharmaceutically acceptable salt thereof is where R^2 is H and R^3 is (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, (C_1-C_{30})acyl,



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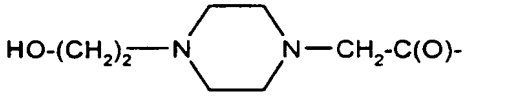

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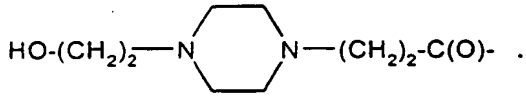


.

A most preferred compound of formula (I) is where said compound is [D-Ala^8, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]-GLP-1(7-34)NH_2; [D-Ala^{8,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2; [Ala^{18,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 83); [Ala^{16,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 84); [Ala^{14,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 85); [Ala^{22,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 86); [Hppa^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 87); [Ala^{15,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 88); [Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 89); [Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 90); [Ala^{15,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 91); [Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 92); [Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 93); [Ala^{21,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 94); [Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2

(SEQ ID NO: 95); [Ala^{22,23,27,32}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 96); [Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 97); [Ala^{22,23,27,31}, 3-Pal^{19}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 98); [Ala^{22,23,27,28}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 99); [Ala^{22,23,27,29}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 100); [Ala^{23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 101); [Ala^{20,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 102); [Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 103); [Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 104); [D-Ala^{10}, Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2; [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2; [Ala^{17,23,27}, 3-Pal^{19,26,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 105); [D-Ala^{8}, Ala^{17}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2; [Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 106); [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{29}]hGLP-1(7-34)-NH_2; [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{16}]hGLP-1(7-34)-NH_2; [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; [D-Ala^{22}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; [Aib^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 107); [D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2; [Aib^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 108); [Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 109); [Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{33}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 110); [Tle^{16}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 111); [N-Me-D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2; [Aib^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 112); [Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16,20}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 113); [D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16}, Gaba^{34}]hGLP-1(7-34)-NH_2; [D-Ala^{8,22}, Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; [D-Ala^{8,18}, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; [D-Ala^{8,17}, Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; or [D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; or a pharmaceutically acceptable salt thereof.

Another most preferred compound of formula (I) is wherein said compound is

[Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2 (SEQ ID NO: 114); [A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 115); [Aib^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 116); [(Tma-His)^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 117); [A6c^{8}]hGLP-1(8-36)-NH_2 (SEQ ID NO: 118); [A6c^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 119); [A6c^{16,20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 120); [A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 121); [A6c^{20}, Aib^{24}]hGLP-1(7-36)-NH$_2$ (SEQ ID NO: 122); [Aib^{24}, A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 123

[A6c^{16,29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 124); [Ura^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 125); [Paa^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 126); [Pta^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 127); [N-Me-Ala^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 128); [N-Me-Ala^8]hGLP-1(8-36)-NH_2; (SEQ ID NO.) [N-Me-D-Ala^8]hGLP-1(7-36)-NH_2; [N-Me-D-Ala^8]hGLP-1(8-36)-NH_2; [N-Me-Gly^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 129); [A5c^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 130); [N-Me-Glu^9]hGLP-1(7-36)-NH_2 (SEQ ID NO: 131); [A5c^8, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 132); [Aib^8, A6c^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 133); [Aib^{8,25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 134); [Aib^{8,24}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 135); [Aib^{8,30}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 136); [Aib^8, Cha^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 137); [Aib^8, Cha^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 138); [Aib^8, Glu^{23}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 139); [Aib^8, A6c^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 140); [Aib^8, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 141); [Aib^{8,22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 142); [Aib^8,β-Ala^{22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 143); [Aib^8, Lys^{25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 144); [Aib^8, A6c^{12}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 145); [Aib^8, A6c^{29}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 146); [Aib^8, A6c^{33}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 147); [Aib^{8,14}]hGLP-1(7-36)NH_2 (SEQ ID NO: 148); [Aib^{8,18}]hGLP-1(7-36)NH_2 (SEQ ID NO: 149); or [Aib^{8,17}]hGLP-1(7-36)NH_2 (SEQ ID NO: 150); or a pharmaceutically acceptable salt thereof. In another aspect, the present invention provides a pharmaceutical composition comprising an effective amount of a compound of formula (I) as defined hereinabove or a pharmaceutically acceptable salt thereof and a pharmaceutically acceptable carrier or diluent.

In still another aspect, the present invention provides a method of eliciting an agonist effect from a GLP-1 receptor in a subject in need thereof which comprises administering to said subject an effective amount of a compound of formula (I) as defined hereinabove or a pharmaceutically acceptable salt thereof.

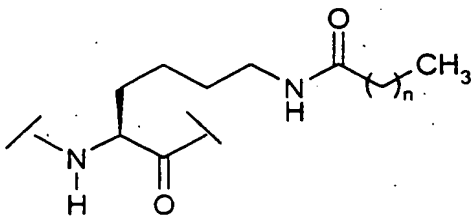
In yet a further aspect, this invention provides a method of treating a disease selected from the group consisting of Type I diabetes, Type II diabetes, obesity, glucagonomas, secretory disorders of the airway, metabolic disorder, arthritis, osteoporosis, central nervous system disease, restenosis and neurodegenerative disease, renal failure, congestive heart failure, nephrotic syndrome, cirrhosis, pulmonary edema, hypertension, and disorders wherein the reduction of food intake is desired, in a subject in need thereof which comprises administering to said subject an effective amount of a compound of formula (I) as

defined hereinabove or a pharmaceutically acceptable salt thereof. Preferred of the foregoing method is where the disease is Type I diabetes or Type II diabetes.

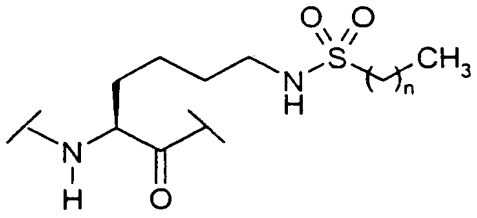
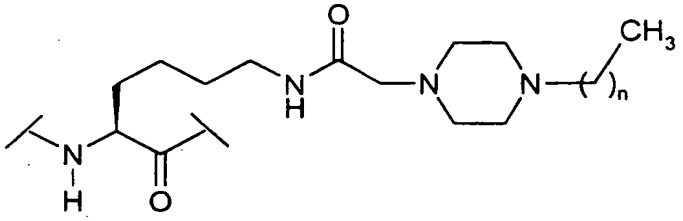
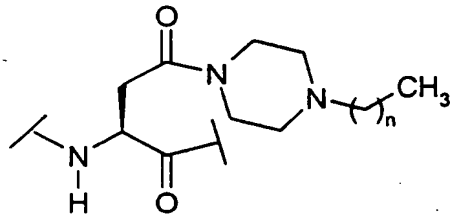
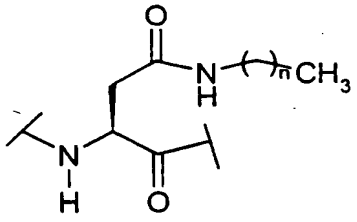
With the exception of the N-terminal amino acid, all abbreviations (e.g. Ala) of amino acids in this disclosure stand for the structure of -NH-CH(R)-CO-, wherein R is the side chain of an amino acid (e.g., CH_3 for Ala). For the N-terminal amino acid, the abbreviation stands for the structure of (R^2R^3)-N-CH(R)-CO-, wherein R is a side chain of an amino acid and R^2 and R^3 are as defined above except in the case where A^7 is Ura, Paa, Pta or Hppa in which case R^2 and R^3 are not present since Ura, Paa, Pta and Hppa are considered here as des-amino amino acids. The abbreviations: β-Nal, Nle, Cha, Amp, 3-Pal, 4-Pal and Aib stand for the following α-amino acids: β-(2-naphthyl)alanine, norleucine, cyclohexylalanine, 4-amino-phenylalanine, β-(3-pyridinyl)alanine, β-(4-pyridinyl)alanine and α-aminoisobutyric acid, respectively. Other amino acid definitions are: Ura is urocanic acid; Pta is (4-pyridylthio) acetic acid; Paa is *trans*-3-(3-pyridyl) acrylic acid; Tma-His is N,N-tetramethylamidino-histidine; N-Me-Ala is N-methyl-alanine; N-Me-Gly is N-methyl-glycine; N-Me-Glu is N-methyl-glutamic acid; Tle is *tert*-butylglycine; Abu is α-aminobutyric acid; Tba is *tert*-butylalanine; Orn is ornithine; Aib is α-aminoisobutyric acid; β-Ala is β-alanine; Gaba is γ-aminobutyric acid; Ava is 5-aminovaleric acid; and Aic is 2-aminoindane-2-carboxylic acid.

What is meant by Acc is an amino acid selected from the group of 1-amino-1-cyclopropanecarboxylic acid (A3c); 1-amino-1-cyclobutanecarboxylic acid (A4c); 1-amino-1-cyclopentanecarboxylic acid (A5c); 1-amino-1-cyclohexanecarboxylic acid (A6c); 1-amino-1-cycloheptanecarboxylic acid (A7c); 1-amino-1-cyclooctanecarboxylic acid (A8c); and 1-amino-1-cyclononanecarboxylic acid (A9c). In the above formula, hydroxyalkyl, hydroxyphenylalkyl, and hydroxynaphthylalkyl may contain 1-4 hydroxy substituents. COX^5 stands for $-C{=}O{\cdot}X^5$. Examples of $-C{=}O{\cdot}X^5$ include, but are not limited to, acetyl and phenylpropionyl.

What is meant by Lys(N^ε-alkanoyl) is represented by the following structure:



. What is meant by Lys(N^ε-alkylsulfonyl) is

represented by the following structure:  . What is meant by Lys(N$^{\varepsilon}$-(2-(4-alkyl-1-piperazine)-acetyl)) is represented by the following structure:  . What is meant by Asp(1-(4-alkyl-piperazine)) is represented by the following structure:  . What is meant by Asp(1-alkylamino) is represented by the following structure:  . The variable n in the foregoing structures is 1 to 30.

The full names for other abbreviations used herein are as follows: Boc for t-butyloxycarbonyl, HF for hydrogen fluoride, Fm for formyl, Xan for xanthyl, Bzl for benzyl, Tos for tosyl, DNP for 2,4-dinitrophenyl, DMF for dimethylformamide, DCM for dichloromethane, HBTU for 2-(1H-Benzotriazol-1-yl)-1,1,3,3-tetramethyl uronium hexafluorophosphate, DIEA for diisopropylethylamine, HOAc for acetic acid, TFA for trifluoroacetic acid, 2ClZ for 2-chlorobenzyloxycarbonyl and OcHex for O-cyclohexyl.

A peptide of this invention is also denoted herein by another format, e.g., [A5c^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 130), with the substituted amino acids from the natural sequence placed between the set of brackets (e.g., A5c^{8} for Ala^{8} in

hGLP-1). The abbreviation GLP-1 means glucagon-like peptide-1, and hGLP-1 means human glucagon-like peptide-1. The numbers between the parentheses refer to the number of amino acids present in the peptide (e.g., hGLP-1(7-36) (SEQ ID NO: 3) is amino acids 7 through 36 of the peptide sequence for human GLP-1). The sequence for hGLP-1(7-37) (SEQ ID NO: 4) is listed in Mojsov, S., Int. J. Peptide Protein Res,. 40, 1992, pp. 333-342. The designation "NH_2" in hGLP-1(7-36)NH_2 (SEQ ID NO: 1) indicates that the C-terminus of the peptide is amidated. hGLP-1(7-36) (SEQ ID NO: 2) means that the C-terminus is the free acid.

Detailed Description

The peptides of this invention can be prepared by standard solid phase peptide synthesis. See, e.g., Stewart, J.M., et al., Solid Phase Synthesis (Pierce Chemical Co., 2d ed. 1984). The substituents R^2 and R^3 of the above generic formula can be attached to the free amine of the N-terminal amino acid by standard methods known in the art. For example, alkyl groups, e.g., (C_1-C_{30})alkyl, can be attached using reductive alkylation. Hydroxyalkyl groups, e.g., (C_1-C_{30})hydroxyalkyl, can also be attached using reductive alkylation wherein the free hydroxy group is protected with a t-butyl ester. Acyl groups, e.g., COE^1, may be attached by coupling the free acid, e.g., E^1COOH, to the free amine of the N-terminal amino acid by mixing the completed resin with 3 molar equivalents of both the free acid and diisopropylcarbodiimide in methylene chloride for one hour. If the free acid contains a free hydroxy group, e.g., p-hydroxyphenylpropionic acid, then the coupling should be performed with an additional 3 molar equivalents of HOBT.

When R^1 is NH-X^2-CH_2- $CONH_2$ (i.e., Z^0=$CONH_2$), the synthesis of the peptide starts with BocHN-X^2-CH_2-COOH which is coupled to the MBHA resin. If R^1 is NH-X^2-CH_2-COOH (i.e., Z^0=COOH) the synthesis of the peptide starts with Boc-HN-X^2-CH_2-COOH which is coupled to PAM resin.

The following describes a synthetic method for making a peptide of this invention, which method is well-known to those skilled in the art. Other methods are also known to those skilled in the art.

Benzhydrylamine-polystyrene resin (Advanced ChemTech, Inc., Louisville, KY) (0.9 g, 0.3 mmole) in the chloride ion form is placed in a reaction vessel of an Advanced ChemTech Peptide Synthesizer Model 200 programmed to perform the following reaction cycle: (a) methylene chloride; (b) 33% trifluoroacetic acid in

methylene chloride (2 times for 1 and 15 min each); (c) methylene chloride; (d) ethanol; (e) methylene chloride; (f) l0% diisopropylethylamine in methylene chloride.

The neutralized resin is stirred with Boc-protected amino acid which is to be the C-terminal amino acid of the desired peptide to be synthesized and diisopropylcarbodiimide (3 mmole each) in methylene chloride for 1 hour and the resulting amino acid resin is then cycled through steps (a) through (f) in the above wash program. The other amino acids (3 mmol) of the desired peptide are then coupled successively by the same procedure. The finished peptide is cleaved from the resin by mixing it with anisole (5 ml), dithiothreitol (100 mg) and anhydrous hydrogen fluoride (35 ml) at about 0 °C and stirring it for about 45 min. Excess hydrogen fluoride is evaporated rapidly under a stream of dry nitrogen and free peptide precipitated and washed with ether. The crude peptide is then dissolved in a minimum volume of dilute acetic acid and eluted on a column (2.5 x 25 cm) of VYDAC® octadecylsilane silica (10 mM) and eluted with a linear gradient of 20-60% acetonitrile over about 1 h in 0.1% trifluoroacetic acid in water. Fractions are examined by thin layer chromatography and analytical high performance liquid chromatography (40-70% B at 1%/min, solution B is 80% acetonitrile/water containing 0.1% TFA) and pooled to give maximum purity rather than yield. Repeated lyophilization of the solution from water gives the product as a white, fluffy powder.

The product peptide is analyzed by HPLC. Amino acid analysis of an acid hydrolysate of the product peptide can confirm the composition of the peptide. Laser desorption MS is used to determine the molecular weight of the peptide.

The protected amino acid 1-[N-tert-butoxycarbonyl-amino]-1-cyclohexane-carboxylic acid (Boc-A6c-OH) was synthesized as follows. 19.1 g (0.133 mol) of 1-amino-1-cyclohexanecarboxylic acid (Acros Organics, Fisher Scientific, Pittsburgh, PA) was dissolved in 200 ml of dioxane and 100 ml of water. To it was added 67 ml of 2N NaOH. The solution was cooled in an ice-water bath. 32.0 g (0.147 mol) of di-tert-butyl-dicarbonate was added to this solution. The reaction mixture was stirred overnight at room temperature. Dioxane was then removed under reduced pressure. 200 ml of ethyl acetate was added to the remaining aqueous solution. The mixture was cooled in an ice-water bath. The pH of the aqueous layer was adjusted to about 3 by adding 4N HCl. The organic layer was separated. The aqueous layer was extracted with ethyl acetate (1 x 100 ml). The two organic

layers were combined and washed with water (2 x 150 ml), dried over anhydrous $MgSO_4$, filtered, and concentrated to dryness under reduced pressure. The residue was recrystallized in ethyl acetate/hexanes. 9.2 g of the pure product was obtained. 29% yield.

Boc-A5c-OH was synthesized in an analogous manner to that of Boc-A6c-OH. Other protected Acc amino acids can be prepared in an analogous manner by a person of ordinary skill in the art as enabled by the teachings herein.

In the synthesis of a peptide of this invention containing A5c, A6c and/or Aib, the coupling time is about 2 hrs. for these residues and the residue immediately following them. For the synthesis of [Tma-His^7]hGLP-1(7-36)NH_2 (SEQ ID NO: 117), HBTU (2 mmol) and DIEA (1.0 ml) in 4 ml DMF were used to react with the N-terminal free amine of the peptide-resin in the last coupling reaction; the coupling time is about 2 hours.

The full names for the abbreviations used above are as follows: Boc for t-butyloxycarbonyl, HF for hydrogen fluoride, Fm for formyl, Xan for xanthyl, Bzl for benzyl, Tos for tosyl, DNP for 2,4-dinitrophenyl, DMF for dimethylformamide, DCM for dichloromethane, HBTU for 2-(1H-benzotriazol-1-yl)-1,1,3,3-tetramethyl uronium hexafluorophosphate, DIEA for diisopropylethylamine, HOAc for acetic acid, TFA for trifluoroacetic acid, 2ClZ for 2-chlorobenzyloxycarbonyl, 2BrZ for 2-bromobenzyloxycarbonyl and OcHex for O-cyclohexyl.

The substituents R^2 and R^3 of the above generic formula can be attached to the free amine of the N-terminal amino acid by standard methods known in the art. For example, alkyl groups, e.g., (C_1-C_{30})alkyl, may be attached using reductive alkylation. Hydroxyalkyl groups, e.g., (C_1-C_{30})hydroxyalkyl, can also be attached using reductive alkylation wherein the free hydroxy group is protected with a t-butyl ester. Acyl groups, e.g., COX^1, can be attached by coupling the free acid, e.g., X^1COOH, to the free amine of the N-terminal amino acid by mixing the completed resin with 3 molar equivalents of both the free acid and diisopropylcarbodiimide in methylene chloride for about one hour. If the free acid contains a free hydroxy group, e.g., p-hydroxyphenylpropionic acid, then the coupling should be performed with an additional 3 molar equivalents of HOBT.

A compound of the present invention can be tested for activity as a GLP-1 binding compound according to the following procedure.

Cell Culture:

RIN 5F rat insulinoma cells (ATCC-# CRL-2058, American Type Culture Collection, Manassas, VA), expressing the GLP-1 receptor, were cultured in Dulbecco's modified Eagle's medium (DMEM) containing 10% fetal calf serum, and maintained at about 37 °C in a humidified atmosphere of 5% CO_2/95% air.

Radioligand Binding:

Membranes were prepared for radioligand binding studies by homogenization of the RIN cells in 20 ml of ice-cold 50 mM Tris-HCl with a Brinkman Polytron (Westbury, NY) (setting 6, 15 sec). The homogenates were washed twice by centrifugation (39,000 g / 10 min), and the final pellets were re-suspended in 50 mM Tris-HCl, containing 2.5 mM $MgCl_2$, 0.1 mg/ml bacitracin (Sigma Chemical, St. Louis, MO), and 0.1% BSA. For assay, aliquots (0.4 ml) were incubated with 0.05 nM [^{125}I]GLP-1(7-36) (SEQ ID NO: 151) (~2200 Ci/mmol, New England Nuclear, Boston, MA), with and without 0.05 ml of unlabeled competing test peptides. After a 100 min incubation (25 °C), the bound [^{125}I]GLP-1(7-36) (SEQ ID NO: 151) was separated from the free by rapid filtration through GF/C filters (Brandel, Gaithersburg, MD), which had been previously soaked in 0.5% polyethyleneimine. The filters were then washed three times with 5 ml aliquots of ice-cold 50 mM Tris-HCl, and the bound radioactivity trapped on the filters was counted by gamma spectrometry (Wallac LKB, Gaithersburg, MD). Specific binding was defined as the total [^{125}I]GLP-1(7-36) (SEQ ID NO: 151) bound minus that bound in the presence of 1000 nM GLP1(7-36) (SEQ ID NO: 3) (Bachem, Torrence, CA).

The peptides of this invention can be provided in the form of pharmaceutically acceptable salts. Examples of such salts include, but are not limited to, those formed with organic acids (e.g., acetic, lactic, maleic, citric, malic, ascorbic, succinic, benzoic, methanesulfonic, toluenesulfonic, or pamoic acid), inorganic acids (e.g., hydrochloric acid, sulfuric acid, or phosphoric acid), and polymeric acids (e.g., tannic acid, carboxymethyl cellulose, polylactic, polyglycolic, or copolymers of polylactic-glycolic acids). A typical method of making a salt of a peptide of the present invention is well known in the art and can be accomplished by standard methods of salt exchange. Accordingly, the TFA salt of a peptide of the present invention (the TFA salt results from the purification of the peptide by using preparative HPLC, eluting with TFA containing buffer solutions) can be converted into another salt, such as an acetate salt by dissolving the peptide in a small

amount of 0.25 N acetic acid aqueous solution. The resulting solution is applied to a semi-prep HPLC column (Zorbax, 300 SB, C-8). The column is eluted with (1) 0.1N ammonium acetate aqueous solution for 0.5 hrs., (2) 0.25N acetic acid aqueous solution 0.5 hrs. and (3) a linear gradient (20% to 100% of solution B over 30 min.) at a flow rate of 4 ml/min (solution A is 0.25N acetic acid aqueous solution; solution B is 0.25N acetic acid in acetonitrile/water, 80:20). The fractions containing the peptide are collected and lyophilized to dryness.

As is well known to those skilled in the art, the known and potential uses of GLP-1 is varied and multitudinous [See, Todd, J.F., et al., Clinical Science, 1998, 95, pp. 325-329; and Todd, J.F. et al., European Journal of Clinical Investigation, 1997, 27, pp.533-536]. Thus, the administration of the compounds of this invention for purposes of eliciting an agonist effect can have the same effects and uses as GLP-1 itself. These varied uses of GLP-1 may be summarized as follows, treatment of: Type I diabetes, Type II diabetes, obesity, glucagonomas, secretory disorders of the airway, metabolic disorder, arthritis, osteoporosis, central nervous system diseases, restenosis and neurodegenerative diseases. GLP-1 analogues of the present invention that elicit an antagonist effect from a subject can be used for treating the following: hypoglycemia and malabsorption syndrome associated with gastroectomy or small bowel resection.

Accordingly, the present invention includes within its scope pharmaceutical compositions comprising, as an active ingredient, at least one of the compounds of formula (I) in association with a pharmaceutically acceptable carrier or diluent.

The dosage of active ingredient in the compositions of this invention may be varied; however, it is necessary that the amount of the active ingredient be such that a suitable dosage form is obtained. The selected dosage depends upon the desired therapeutic effect, on the route of administration, and on the duration of the treatment. In general, an effective dosage for the activities of this invention is in the range of $1x10^{-7}$ to 200 mg/kg/day, preferably $1x10^{-4}$ to 100 mg/kg/day, which can be administered as a single dose or divided into multiple doses.

The compounds of this invention can be administered by oral, parenteral (e.g., intramuscular, intraperitoneal, intravenous or subcutaneous injection, or implant), nasal, vaginal, rectal, sublingual or topical routes of administration and can be formulated with pharmaceutically acceptable carriers to provide dosage forms appropriate for each route of administration.

Solid dosage forms for oral administration include capsules, tablets, pills, powders and granules. In such solid dosage forms, the active compound is admixed with at least one inert pharmaceutically acceptable carrier such as sucrose, lactose, or starch. Such dosage forms can also comprise, as is normal practice, additional substances other than such inert diluents, e.g., lubricating agents such as magnesium stearate. In the case of capsules, tablets and pills, the dosage forms may also comprise buffering agents. Tablets and pills can additionally be prepared with enteric coatings.

Liquid dosage forms for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups, the elixirs containing inert diluents commonly used in the art, such as water. Besides such inert diluents, compositions can also include adjuvants, such as wetting agents, emulsifying and suspending agents, and sweetening, flavoring and perfuming agents.

Preparations according to this invention for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, or emulsions. Examples of non-aqueous solvents or vehicles are propylene glycol, polyethylene glycol, vegetable oils, such as olive oil and corn oil, gelatin, and injectable organic esters such as ethyl oleate. Such dosage forms may also contain adjuvants such as preserving, wetting, emulsifying, and dispersing agents. They may be sterilized by, for example, filtration through a bacteria-retaining filter, by incorporating sterilizing agents into the compositions, by irradiating the compositions, or by heating the compositions. They can also be manufactured in the form of sterile solid compositions which can be dissolved in sterile water, or some other sterile injectable medium immediately before use.

Compositions for rectal or vaginal administration are preferably suppositories which may contain, in addition to the active substance, excipients such as coca butter or a suppository wax.

Compositions for nasal or sublingual administration are also prepared with standard excipients well known in the art.

Further, a compound of this invention can be administered in a sustained release composition such as those described in the following patents and patent applications. U.S. Patent No. 5,672,659 teaches sustained release compositions comprising a bioactive agent and a polyester. U.S. Patent No. 5,595,760 teaches sustained release compositions comprising a bioactive agent in a gelable form. U.S.

Application No. 08/929,363 filed September 9, 1997, teaches polymeric sustained release compositions comprising a bioactive agent and chitosan. U.S. Application No. 08/740,778 filed November 1, 1996, teaches sustained release compositions comprising a bioactive agent and cyclodextrin. U.S. Application No. 09/015,394 filed January 29, 1998, teaches absorbable sustained release compositions of a bioactive agent. U.S. Application No. 09/121,653 filed July 23, 1998, teaches a process for making microparticles comprising a therapeutic agent such as a peptide in an oil-in-water process. U.S. Application No. 09/131,472 filed August 10, 1998, teaches complexes comprising a therapeutic agent such as a peptide and a phosphorylated polymer. U.S. Application No. 09/184,413 filed November 2, 1998, teaches complexes comprising a therapeutic agent such as a peptide and a polymer bearing a non-polymerizable lactone. The teachings of the foregoing patents and applications are incorporated herein by reference.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Also, all publications, patent applications, patents and other references mentioned herein are incorporated by reference.

The following examples describe synthetic methods for making a peptide of this invention, which methods are well-known to those skilled in the art. Other methods are also known to those skilled in the art. The examples are provided for the purpose of illustration and is not meant to limit the scope of the present invention in any manner.

Example 1

[D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]-GLP-1(7-34)NH_2

Benzhydrylamine-polystyrene resin (Advanced ChemTech, Inc. Louisville, KY) (0.9 g, 0.3 mmole) in the chloride ion form was placed in a reaction vessel of an Advanced ChemTech peptide synthesizer Model 200 programmed to perform the following reaction cycle: (a) methylene chloride; (b) 33% trifluoroacetic acid in methylene chloride (2 times for 1 and 15 min each); (c) methylene chloride; (d) ethanol; (e) methylene chloride; (f) 10% diisopropylethylamine in methylene chloride.

The neutralized resin was stirred with Boc-Gaba and diisopropylcarbodiimide (3 mmole each) in methylene chloride for 1 hour and the resulting amino acid resin was then cycled through steps (a) to (f) in the above wash program. The following amino acids (3 mmole) were then coupled

successively by the same procedure: Boc-Val, Boc-Leu, Boc-3-Pal, Boc-Ala, Boc-Ile, Boc-Phe, Boc-Ala, Boc-Lys(2-Cl-Z), Boc-Ala, Boc-Ala, Boc-Ala, Boc-Ala, Boc-Glu(Bzl), Boc-Leu, Boc-3-Pal, Boc-Ser(Bzl), Boc-Ala, Boc-Val, Boc-Asp(Bzl), Boc-Ser(Bzl), Boc-Thr(Bzl), Boc-Phe, Boc-Thr(Bzl), Boc-Gly, Boc-Glu(Bzl), Boc-D-Ala, Boc-His(Bom).

The resin with the completed peptide sequence was mixed with anisole (5 ml), dithiothreitol (100 mg) and anhydrous hydrogen fluoride (35 ml) at about 0 °C and stirred for about 45 min. Excess hydrogen fluoride was evaporated rapidly under a stream of dry nitrogen and free peptide precipitated and washed with ether. The crude peptide was then dissolved in a minimum volume of dilute acetic acid and eluted on a column (2.5 x 25 cm) of VYDAC® octadecylsilane silica (10 mM) and eluted with a linear gradient of 20-60% acetonitrile over about 1 h in 0.1% trifluoroacetic acid in water. Fractions were examined by thin layer chromatography and analytical high performance liquid chromatography (40-70% B at 1%/min; r.t.: 14.1 min) and pooled to give maximum purity rather than yield. Repeated lyophilization of the solution from water gives the product (49.9 mg) as a white, fluffy powder.

The product was found to be homogeneous by HPLC and tlc. Amino acid analysis of an acid hydrolysate confirms the composition of the peptide. Laser desorption MS gave a MW of 2880 (Calc. M+H 2873).

Example 2

Synthesis of Peptide Lower-Alkylamides

Peptides are assembled on O-benzyl-polystyrene resin (often referred to as Merrifield resin) using the Boc amino acid protocol described in Example 1, except that Asp and Glu amino acid carboxyl side-chains are protected with an Fm (fluorenylmethyl ester) group. Completed peptide-resins are suspended in dilute DMF solutions of an appropriate lower alkylamine (such as ethylamine, propylamine, phenethylamine, 1,2-diaminoethane, etc.) and stirred at about 60 °C (for about 18 hrs) whereupon filtration, removal of solvents under reduced pressure and trituration of cleaved peptide oil with ether gives a solid, protected alkylamide peptide. This is then subjected to HF cleavage to remove additional side chain protecting groups and HPLC purification as described in Example 1.

Examples 3-5

Examples 3-5 can be synthesized substantially according to the procedure described in Example 1 using the appropriate protected amino acids to yield the noted peptides.

Example 3: [Aib^{8}, D-Ala^{17}, Ala^{18,22,23,27}, 3-Pal^{19,31}, Tle^{16}, Gaba^{34}]-GLP-1(7-34)NH_2

Example 4: [Aib^{8}, D-Ala^{17}, Ala^{22,23,27}, 3-Pal^{19,31}, Tle^{16}]-GLP-1(7-33)NH_2

Example 5: [Aib^{8}, D-Ala^{17}, Ala^{22,23,27}, 3-Pal^{19,31}, Tle^{16,20}]-GLP-1(7-33)NH_2

Examples 6-51

Examples 6-51 were made substantially according to the procedure described for Example 1 but using the appropriate protected amino acid to yield the noted peptide. MS were obtained by laser desorption MS (NA means not available).

Example 6: [D-Ala^{8,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2; MS = 2971.0; Calc. MW = 2974.4.

Example 7: [Ala^{18,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 83); MS = 2954.4; Calc. MW = 2958.4.

Example 8: [Ala^{16,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 84); MS = 2943.0; Calc. MW = 2946.3.

Example 9: [Ala^{14,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 85); MS = 2956.0; Calc. MW = 2958.4.

Example 10: [Ala^{22,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 86); MS = 2981.0; Calc. MW = 2988.4.

Example 11: [Hppa^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 87); MS = NA

Example 12: [Ala^{15,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 88); MS = 2928.0; Calc. MW = 2930.4.

Example 13: [Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 89); MS = 2955.0; Calc. MW = 2958.4.

Example 14: [Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 90); MS = 2896.0; Calc. MW = 2888.3.

Example 15: [Ala^{15,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 91); MS = 2852.0; Calc. MW = 2844.3.

Example 16: [Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 92); MS = 2880.0; Calc. MW = 2872.3.

Example 17: [Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 93); MS = 2870.0; Calc. MW = 2872.3.

Example 18: [Ala^{21,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 94); MS = NA.

Example 19: [Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 95); MS = 2832.0; Calc. MW = 2831.2.

Example 20: [Ala^{22,23,27,32}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 96); MS = 2855.0; Calc. MW = 2846.2.

Example 21: [Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 97); MS = 2729.0; Calc. MW = 2732.0.

Example 22: [Ala^{22,23,27,31}, 3-Pal^{19}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 98); MS = 2711.6; Calc. MW = 2712.0.

Example 23: [Ala^{22,23,27,28}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 99); MS = 2712.0; Calc. MW = 2713.0.

Example 24: [Ala^{22,23,27,29}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 100); MS = 2746.9; Calc. MW = 2747.1.

Example 25: [Ala^{23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 101); MS = 2777.0; Calc. MW = 2,775.1.

Example 26: [Ala^{20,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 102); MS = 2742.0; Calc. MW = 2747.1.

Example 27: [Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 103); MS = 2786.7; Calc. MW = 2789.1.

Example 28: [Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 104); MS = 2771.0; Calc. MW = 2773.1.

Example 29: [D-Ala^{10}, Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2; MS = 2802.0; Calc. MW = 2803.2.

Example 30: [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2; MS = 2905.0; Calc. MW = 2901.3.

Example 31: [Ala^{17,23,27}, 3-Pal^{19,26,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 105); MS = 2920.0; Calc. MW = 2921.3.

Example 32: [D-Ala^{8}, Ala^{17}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2; MS = 2908.0 (Na^+ salt); Calc. MW = 2885.3.

Example 33: [Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 106); MS = 2907.0; Calc. MW = 2901.3.

Example 34: [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{29}]hGLP-1(7-34)-NH_2; MS = 2906.0; Calc. MW = 2901.3.

Example 35: [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{16}]hGLP-1(7-34)-NH_2; MS = 2914.0; Calc. MW = 2915.4.

Example 36: [D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = 2856.8; Calc. MW = 2858.2.

Example 37: [D-Ala^{22}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = 2871.0; Calc. MW = 2872.3.

Example 38: [Aib^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 107); MS = 2875.0; Calc. MW = 2872.3.

Example 39: [D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2; MS = 2786.0; Calc. MW = 2787.2.

Example 40: [Aib^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 108); MS = 2800.0; Calc. MW = 2801.2.

Example 41: [Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 109); MS = 2842.5; Calc. MW = 2842.2.

Example 42: [Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{33}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 110); MS = 2871.0; Calc. MW = 2872.3.

Example 43: [Tle^{16}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 111); MS = 2870.0; Calc. MW = 2872.3.

Example 44: [N-Me-D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2; MS = 2795.0; Calc. MW = 2801.2.

Example 45: [Aib^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 112); MS = 2784.2; Calc. MW = 2785.2.

Example 46: [Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16,20}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 113); MS = 2871.9; Calc. MW = 2870.3.

Example 47: [D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = 2870.0; Calc. MW = 2870.3.

Example 48: [D-Ala^{8,22}, Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = 2856.3; Calc. MW = 2856.3.

Example 49: [D-Ala^{8,18}, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = NA.

Example 50: [D-Ala^{8,17}, Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = NA.

Example 51: [D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; MS = 2861.6; Calc. MW = 2856.3.

Example 52

[Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2 (SEQ ID NO: 114)

The title peptide was synthesized on an Applied Biosystems (Foster City, CA) model 430A peptide synthesizer which was modified to do accelerated Boc-chemistry solid phase peptide synthesis. See Schnolzer, et al., Int. J. Peptide Protein Res., 40:180 (1992). 4-Methylbenzhydrylamine (MBHA) resin (Peninsula, Belmont, CA) with the substitution of 0.91 mmol/g was used. The Boc amino acids (Bachem, CA, Torrance, CA; Nova Biochem., LaJolla, CA) were used with the following side chain protection: Boc-Ala-OH, Boc-Arg(Tos)-OH, Boc-Asp(OcHex)-OH, Boc-Tyr(2BrZ)-OH, Boc-His(DNP)-OH, Boc-Val-OH, Boc-Leu-OH, Boc-Gly-OH, Boc-Gln-OH, Boc-Ile-OH, Boc-Lys(2ClZ)-OH, Boc-Thr(Bzl)-OH, Boc-A6c-OH, Ser(Bzl)-OH, Boc-Phe-OH, Boc-Aib-OH, Boc-Glu(OcHex)-OH and Boc-Trp(Fm)-OH. The synthesis was carried out on a 0.20 mmol scale. The Boc groups were removed by treatment with 100% TFA for 2 x 1 min. Boc amino acids (2.5 mmol) were pre-activated with HBTU (2.0 mmol) and DIEA (1.0 ml) in 4 ml of DMF and were coupled without prior neutralization of the peptide-resin TFA salt. Coupling times were about 5 min except for the Boc-Aib-OH and Boc-A6c-OH residues and the following residues, Boc-Trp(Fm)-OH and Boc-His(DNP)-OH wherein the coupling times were about 2 hours.

At the end of the assembly of the peptide chain, the resin was treated with a solution of 20% mercaptoethanol/10% DIEA in DMF for 2 x 30 min to remove the DNP group on the His side chain. The N-terminal Boc group was then removed by treatment with 100% TFA for 2 x 2 min. After neutralization of the peptide-resin with 10% DIEA in DMF (1 x 1 min), the formyl group on the side of the chain of Trp was removed by treatment with a solution of 15% ethanolamine/ 15% water/ 70% DMF for 2 x 30 min. The partially-deprotected peptide-resin was washed with DMF and DCM and dried under reduced pressure. The final cleavage was done by stirring the peptide-resin in 10 ml of HF containing 1 ml of anisole and dithiothreitol (24 mg) at 0 °C for about 75 min. HF was removed with a flow of nitrogen. The residue was washed with ether (6 x 10 ml) and extracted with 4N HOAc (6 x 10 ml).

The peptide mixture in the aqueous extract was purified on a reverse-phase preparative high pressure liquid chromatography (HPLC) using a reverse phase VYDAC® C_{18} column (Nest Group, Southborough, MA). The column was eluted with a linear gradient (20% to 50% of solution B over 105 min) at a flow rate of 10

ml/min (Solution A = water containing 0.1% TFA; Solution B = acetonitrile containing 0.1% of TFA). Fractions were collected and checked on analytical HPLC. Those containing pure product were combined and lyophilized to dryness. 92 mg of a white solid was obtained. Purity was >99% based on analytical HPLC analysis. Electro-spray mass spectrometer analysis gave the molecular weight at 3324.2 (the calculated molecular weight is 3323.7).

The synthesis of other compounds of the present invention can be carried out in the same manner as described for the synthesis of [Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2 (SEQ ID NO: 114) in Example 52 above but using the appropriate protected amino acids depending on the desired peptide.

[(N$^{\alpha}$-HEPES-His)^{7}]hGLP-1(7-36)NH_2 (SEQ ID NO: 152) {HEPES is (4-(2-hydroxyethyl)-1-piperazine-ethanesulfonic acid)} can be synthesized as follows: After assembly of the peptide long chain on MBHA resin (0.20 mmol), the peptide-resin is treated with 100% TFA (2 x 2 min.) and washed with DMF and DCM. The resin is then neutralized with 10% DIEA in DMF for about 2 min. After washing with DMF and DCM, the resin is treated with 0.23 mmol of 2-chloro-1-ethanesulfonyl chloride and 0.7 mmol of DIEA in DMF for about 1 hour. The resin is washed with DMF and DCM and treated with 1.2 mmol of 2-hydroxyethylpiperazine for about 2 hours. The resin is washed with DMF and DCM and treated with different reagents ((1) 20% mercaptoethanol / 10% DIEA in DMF and (2) 15% ethanolamine / 15% water / 70% DMF) to remove the DNP group from the His side chain and formyl group on the Trp side chain as described above before the final HF cleavage of the peptide from the resin.

[(N$^{\alpha}$-HEPA-His)^{7}]hGLP-1(7-36)NH_2 (SEQ ID NO: 153) ([(4-(2-hydroxyethyl)-1-piperazineacetyl)-His^{7}]hGLP-1(7-36)NH_2) can be made substantially according to the procedure described immediately above for making [(N$^{\alpha}$-HEPES-His)^{7}]hGLP-1(7-36)NH_2 (SEQ ID NO: 152) except that 2-bromo-acetic anhydride is used in place of 2-chloro-1-ethanesulfonyl chloride.

Examples 53-90 and 104

Examples 53-90 and 104 were made substantially according to Example 52 but using the appropriate protected amino acid.

Example 53: [A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO:115); MS =3322.3 ; Calc. MW = 3321.7.

Example 54: [Aib^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 116); MS = 3311.7; Calc. MW = 3311.7.

Example 55: [(Tma-His)^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 117); MS = 3395.9; Calc. MW = 3396.9.

Example 56: [A6c^8]hGLP-1(8-36)-NH_2 (SEQ ID NO: 118); MS = 3214.5; Calc. MW = 3214.7.

Example 57: [A6c^8]hGLP-1(7-36)-NH_2 (SEQ ID NO:119); MS = 3351.5; Calc. MW = 3351.8.

Example 58: [A6c^{16,20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 120); MS = 3335.9; Calc. MW = 3335.8.

Example 59: [A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 121); MS = 3321.7; Calc. MW = 3321.7.

Example 60: [A6c^{20}, Aib^{24}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 122); MS = 3323.6; Calc. MW = 3323.7.

Example 61: [Aib^{24}, A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 123); MS = 3335.7; Calc. MW = 3335.8.

Example 62: [A6c^{16,29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 124); MS = 3347.7; Calc. MW = 3347.8.

Example 63: [Ura^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 125); MS = 3279.5; Calc. MW = 3280.7.

Example 64: [Paa^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 126); MS = 3290.9; Calc. MW = 3291.8.

Example 65: [Pta^7]hGLP-1(7-36)-NH_2 (SEQ ID NO: 127); MS = 3311.2; Calc. MW = 3311.8.

Example 66: [N-Me-Ala^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 128); MS = 3311.4; Calc. MW = 3311.7.

Example 67: [N-Me-D-Ala^8]hGLP-1(7-36)-NH_2; MS = 3311.6; Calc. MW = 3311.7.

Example 68: [N-Me-D-Ala^8]hGLP-1(8-36)-NH_2; MS = 3174.0; Calc. MW = 3174.6.

Example 69: [N-Me-Gly^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 129); MS = 3297.3; Calc. MW = 3297.7.

Example 70: [A5c^8]hGLP-1(7-36)-NH_2 (SEQ ID NO: 130); MS = 3337.3; Calc. MW = 3337.8.

Example 71: [N-Me-Glu^9]hGLP-1(7-36)-NH_2 (SEQ ID NO: 131); MS = 3311.4; Calc. MW = 3311.7.

Example 72: [A5c^{8}, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 132); MS = 3361.4; Calc. MW = 3361.8.

Example 73: [Aib^{8}, A6c^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 133); MS = 3323.2; Calc. MW = 3323.7.

Example 74: [Aib^{8,25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 134); MS = 3325.8; Calc. MW = 3325.7.

Example 75: [Aib^{8,24}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 135); MS = 3325.8; Calc. MW = 3325.7.

Example 76: [Aib^{8,30}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 136); MS = 3326.1; Calc. MW = 3325.7.

Example 77: [Aib^{8}, Cha^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 137); MS = 3351.8; Calc. MW = 3351.8.

Example 78: [Aib^{8}, Cha^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 138); MS = 3352.0; Calc. MW = 3351.8.

Example 79: [Aib^{8}, Glu^{23}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 139); MS = 3311.7; Calc. MW = 3312.7.

Example 80: [Aib^{8}, A6c^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 140); MS = 3323.6; Calc. MW = 3323.7.

Example 81: [Aib^{8}, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 141); MS = 3335.3; Calc. MW = 3335.7.

Example 82: [Aib^{8,22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 142); MS = 3339.8; Calc. MW = 3339.8.

Example 83: [Aib^{8},β-Ala^{22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 143); MS = 3325.6; Calc. MW = 3325.8.

Example 84: [Aib^{8}, Lys^{25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 144); MS = 3369.0; Calc. MW = 3368.8.

Example 85: [Aib^{8}, A6c^{12}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 145); MS = 3289.8; Calc. MW = 3289.7.

Example 86: [Aib^{8}, A6c^{29}]hGLP-1(7-36)-NH_2 (SEQ ID NO:146); MS = 3323.9; Calc. MW = 3323.7.

Example 87: [Aib^{8}, A6c^{33}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 147); MS = 3338.0; Calc. MW = 3337.8.

Example 88: [Aib^{8,14}]hGLP-1(7-36)NH_2 (SEQ ID NO: 148); MS = 3309.8; Calc. MW = 3309.7.

Example 89: [Aib^{8,18}]hGLP-1(7-36)NH_2 (SEQ ID NO: 149); MS = 3309.7; Calc. MW = 3309.7.

Example 90: [Aib^{8,17}]hGLP-1(7-36)NH_2 (SEQ ID NO: 150); MS = 3309.4; Calc. MW = 3309.7.

Example 104: [Aib^{8}, D-Arg;^{26}]hGLP-1(7-36)NH_2; MS = 3310.7; Calc. MW = 3311.73.

Example 91

[Aib^{8}, A5c^{33}]hGLP-1 (7-36)NH_2 (SEQ ID NO: 154)

The title compound can be made substantially according to Example 52 using the appropriate protected amino acids.

Example 92

[Aib^{8}, A6c^{32}, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 (SEQ ID NO: 155)

The Boc amino acids to be used are the same as those in the synthesis of [Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2 (SEQ ID NO: 114) (Example 52) except that Fmoc-Lys(Boc)-OH is used here for the Lys^{36}(N^{ε}-tetradecanoyl) residue. The first amino acid residue is coupled to the resin manually on a shaker. 2.5 mmol of Fmoc-Lys(Boc)-OH is dissolved in 4 ml of 0.5N HBTU in DMF. To the solution is added 1 ml of DIEA. The mixture is shaken for about 2 min. To the solution is then added 0.2 mmol of MBHA resin (substitution = 0.91 mmol/g). The mixture is shaken for about 1 hr. The resin is washed with DMF and treated with 100% TFA for 2x2 min to remove the Boc protecting group. The resin is washed with DMF. Myristic acid (2.5 mmol) is pre-activated with HBTU (2.0 mmol) and DIEA (1.0 ml) in 4 ml of DMF for 2 min and is coupled to the Fmoc-Lys-resin. The coupling time is about 1 hr. The resin is washed with DMF and treated with 25% piperidine in DMF for 2x20 min to remove the Fmoc protecting group. The resin is washed with DMF and transferred to the reaction vessel of the peptide synthesizer. The remainder of the synthesis and purification procedures of the peptide are the same as those in the synthesis of [Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2. (SEQ ID NO: 114)

The syntheses of other compounds containing Lys(N^{ε}-alkanoyl) residue are carried out in an analogous manner as described for the synthesis of [Aib^{8}, A6c^{32}, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 SEQ ID NO: 155). Fmoc-Lys(Boc)-OH amino acid is used for the residue of Lys(N^{ε} -alkanoyl) in the peptide, while Boc-Lys(2ClZ)-OH amino acid is used for the residue of Lys. If the Lys(N^{ε}-alkanoyl)

residue is not at the C-terminus, the peptide fragment immediately prior to the Lys(N^{ε}-alkanoyl) residue is assembled on the resin on the peptide synthesizer first.

Examples 93-98

Examples 93-98 can be made substantially according to the procedure described for Example 92 using the appropriate amino acids.

Example 93: [Aib^{8}, $A6c^{32}$, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 (SEQ ID NO: 155)

Example 94: [Aib^{8}, $Arg^{26,34}$, $A6c^{32}$, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 (SEQ ID NO: 156)

Example 95: [Aib^{8}, Arg^{26}, $A6c^{32}$, Lys^{34}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 (SEQ ID NO: 157)

Example 96: [Aib^{8}, Lys^{26}(N^{ε}-tetradecanoyl), $A6c^{32}$, Arg^{34}]hGLP-1(7-36)NH_2 (SEQ ID NO: 158)

Example 97: [Aib^{8}, Lys^{36}(N^{ε}-octanoyl)]hGLP-1 (7-36)NH_2 (SEQ ID NO: 159)

Example 98: [Aib^{8}, $A6c^{20,32}$, Lys^{36}(N^{ε}-octanoyl)]hGLP-1 (7-36)NH_2 (SEQ ID NO: 160)

Example 99

[Aib^{8}, $Arg^{26,34}$, $A6c^{32}$, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)-OH (SEQ ID NO: 161)

The Boc amino acids to be used are the same as those used in the synthesis of [Aib^{8}, $A6c^{32}$, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)NH_2 (SEQ ID NO: 162) (Example 92). Fmoc –Lys(Boc)-OH (2.5 mmol) is pre-activated with HBTU (2.0 mmol), HOBt (2.0 mmol) and DIEA (2.5 ml) in DMF (4 ml) for about 2 min. This amino acid is coupled to 235 mg of PAM resin (Chem-Impex, Wood Dale, IL; substitution = 0.85 mmol/g) manually on a shaker. The coupling time is about 8 hrs. The remainder of the synthesis and purification procedures for making the peptide are the same as those described in Example 52.

The syntheses of other analogs of hGLP-1(7-36)-OH (SEQ ID NO: 3) and hGLP-1(7-37)-OH, (SEQ ID NO: 4) which contain Lys(N^{ε}-alkanoyl) residue, are carried out in an analogous manner as described for the synthesis of [Aib^{8}, $Arg^{26,34}$, $A6c^{32}$, Lys^{36}(N^{ε}-tetradecanoyl)]hGLP-1(7-36)-OH (SEQ ID NO: 161). Fmoc-Lys(Boc)-OH amino acid is used for the residue of Lys(N^{ε}-alkanoyl) in the peptide. while Boc-Lys(2ClZ)-OH amino acid is used for the residue of Lys.

Examples 100-103

Examples 100-103 can be made substantially according to the procedure described for Example 99 using the appropriate amino acids.

Example 100: [Aib^{8}, Arg^{26}, A6c^{32}, Lys^{34}(N$^{\varepsilon}$-tetradecanoyl)]hGLP-1(7-36)-OH (SEQ ID NO: 162)

Example 101: [Aib^{8}, Lys^{26}(N$^{\varepsilon}$-tetradecanoyl), A6c^{32}, Arg^{34}]hGLP-1(7-36)-OH (SEQ ID NO: 163)

Example 102: [Aib^{8}, Arg^{26,34}, A6c^{32}, Lys^{36}(N$^{\varepsilon}$-tetradecanoyl)]hGLP-1(7-37)-OH (SEQ ID NO: 164)

Example 103: [Aib^{8}, Arg^{26}, A6c^{32},Lys^{34}(N$^{\varepsilon}$-tetradecanoyl)]hGLP-1(7-37)-OH (SEQ ID NO: 165)

CLAIMS

What is claimed is:

1. A compound of formula (I),

(R^2R^3)- A^7 -A^8 -A^9 -A^{10} -A^{11} -A^{12} -A^{13} -A^{14} -A^{15} -A^{16} -A^{17} -A^{18} -A^{19} -A^{20} -A^{21} -A^{22} -A^{23} - A^{24} -A^{25} -A^{26} -A^{27} -A^{28} -A^{29} -A^{30} -A^{31} -A^{32} -A^{33} -A^{34} -A^{35} -A^{36} –A^{37}- R^1 ,

(I)

wherein

A^7 is L-His, Ura, Paa, Pta, D-His, Tyr, 3-Pal, 4-Pal, Hppa, Tma-His, Amp or deleted, provided that when A^7 is Ura, Paa, Pta or Hppa then R^2 and R^3 are deleted;

A^8 is Ala, D-Ala, Aib, Acc, N-Me-Ala, N-Me-D-Ala, Arg or N-Me-Gly;

A^9 is Glu, N-Me-Glu, N-Me-Asp or Asp;

A^{10} is Gly, Acc, Ala, D-Ala, Phe or Aib;

A^{11} is Thr or Ser;

A^{12} is Phe, Acc, Aic, Aib, 3-Pal, 4-Pal, β-Nal, Cha, Trp or X^1-Phe;

A^{13} is Thr or Ser;

A^{14} is Ser, Thr, Ala or Aib;

A^{15} is Asp, Ala, D-Asp or Glu;

A^{16} is Val, D-Val, Acc, Aib, Leu, Ile, Tle, Nle, Abu, Ala, D-Ala, Tba or Cha;

A^{17} is Ser, Ala, D-Ala, Aib, Acc or Thr;

A^{18} is Ser, Ala, D-Ala, Aib, Acc or Thr;

A^{19} is Tyr, D-Tyr, Cha, Phe, 3-Pal, 4-Pal, Acc, β-Nal, Amp or X^1-Phe;

A^{20} is Leu, Ala, Acc, Aib, Nle, Ile, Cha, Tle, Val, Phe or X^1-Phe;

A^{21} is Glu, Ala or Asp;

A^{22} is Gly, Acc, Ala, D-Ala, β-Ala or Aib;

A^{23} is Gln, Asp, Ala, D-Ala, Aib, Acc, Asn or Glu;

A^{24} is Ala, Aib, Val, Abu, Tle or Acc;

A^{25} is Ala, Aib, Val, Abu, Tle, Acc, Lys, Arg, hArg, Orn, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O) or HN-CH($(CH_2)_e$-X^3)-C(O);

A^{26} is Lys, Ala, 3-Pal, 4-Pal, Arg, hArg, Orn, Amp, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O) or HN-CH($(CH_2)_e$-X^3)-C(O);

A^{27} is Glu, Ala, D-Ala or Asp;

A^{28} is Phe, Ala, Pal, β-Nal, X^1-Phe, Aic, Acc, Aib, Cha or Trp;

A^{29} is Ile, Acc, Aib, Leu, Nle, Cha, Tle, Val, Abu, Ala, Tba or Phe;

A^{30} is Ala, Aib, Acc or deleted;

A^{31} is Trp, Ala, β-Nal, 3-Pal, 4-Pal, Phe, Acc, Aib, Cha, Amp or deleted;

A^{32} is Leu, Ala, Acc, Aib, Nle, Ile, Cha, Tle, Phe, X^1-Phe, Ala or deleted;

A^{33} is Val, Acc, Aib, Leu, Ile, Tle, Nle, Cha, Ala, Phe, Abu, X^1-Phe, Tba, Gaba or deleted;

A^{34} is Lys, Arg, hArg, Orn, Amp, Gaba, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O), HN-CH($(CH_2)_e$-X^3)-C(O) or deleted;

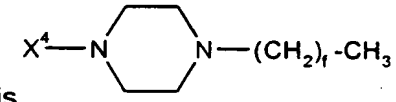
A^{35} is Gly or deleted;

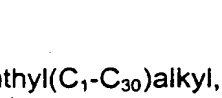
A^{36} is L- or D-Arg, D- or L-Lys, D- or L-hArg, D- or L-Orn, Amp, HN-CH($(CH_2)_n$-$NR^{10}R^{11}$)-C(O), HN-CH($(CH_2)_e$-X^3)-C(O) or deleted;

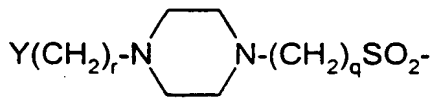
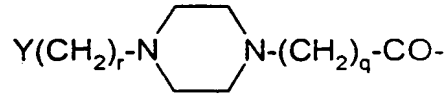
A^{37} is Gly or deleted;

X^1 for each occurrence is independently selected from the group consisting of (C_1-C_6)alkyl, OH and halo;

R^1 is OH, NH_2, (C_1-C_{12})alkoxy, or NH-X^2-CH_2-Z^0, wherein X^2 is a (C_1-C_{12})hydrocarbon moiety, and Z^0 is H, OH, CO_2H or $CONH_2$;

X^3 is  or –C(O)-NHR^{12}, wherein X^4 for each occurrence is independently -C(O)-, -NH-C(O)- or -CH_2-, and f for each occurrence is independently an integer from 1 to 29;

each of R^2 and R^3 is independently selected from the group consisting of H, (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, phenyl(C_1-C_{30})alkyl, naphthyl(C_1-C_{30})alkyl, hydroxy(C_1-C_{30})alkyl, hydroxy(C_2-C_{30})alkenyl, hydroxyphenyl(C_1-C_{30})alkyl, and hydroxynaphthyl(C_1-C_{30})alkyl; or one of R^2 and R^3 is C(O)X^5 in which X^5 is (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, phenyl(C_1-C_{30})alkyl, naphthyl(C_1-C_{30})alkyl, hydroxy(C_1-C_{30})alkyl, hydroxy(C_2-C_{30})alkenyl, hydroxyphenyl(C_1-C_{30})alkyl, hydroxynaphthyl(C_1-C_{30})alkyl,  ,

 or 

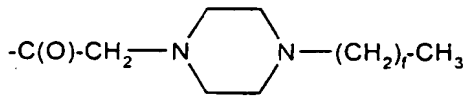
(a) (b)

where Y is H or OH, r is 0 to 4 and q is 0 to 4;

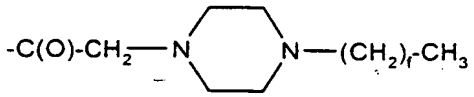
e for each occurrence is independently an integer from 1 to 4;

n for each occurrence is independently an integer from 1-5; and

R^{10} and R^{11} for each occurrence is each independently H, (C_1-C_{30})alkyl, (C_1-C_{30})acyl, (C_1-C_{30})alkylsulfonyl, –C((NH)(NH_2)) or



, provided that when R^{10} is (C_1-C_{30})acyl,



(C_1-C_{30})alkylsulfonyl, –C((NH)(NH_2)) or ,

R^{11} is H or (C_1-C_{30})alkyl; and

R^{12} is (C_1-C_{30})alkyl;

with the proviso that:

(i) at least one amino acid of a compound of formula (I) is not the same as the native sequence of hGLP-1(7-36, or -37)NH_2 (SEQ ID NOS: 1, 2) or hGLP-1(7-36, or -37)OH (SEQ ID NOS: 3, 4);

(ii) a compound of formula (I) is not an analogue of hGLP-1(7-36, or -37)NH_2 (SEQ ID NOS: 1,2) or hGLP-1(7-36, or -37)OH (SEQ ID NOS: 3, 4) wherein a single position has been substituted by Ala;

(iii) a compound of formula (I) is not [Lys^{26}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 5-8), [Lys^{34}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 9-12), [$Lys^{26,34}$-bis(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E (SEQ ID NOS: 13-16), [Arg^{26}, Lys^{34}(N^{ε}-alkanoyl)]hGLP-1(8-36, or -37)-E (SEQ ID NOS: 17-20), or [$Arg^{26,34}$, Lys^{36}(N^{ε}-alkanoyl)]hGLP-1(7-36, or -37)-E, wherein E is -OH or -NH_2 (SEQ ID NOS: 21-24);

(iv) a compound of formula (I) is not Z^1-hGLP-1(7-36, or -37)-OH, Z^1-hGLP-1(7-36, or -37)-NH_2, where Z^1 is selected from the group consisting of

(a) [Arg^{26}] (SEQ ID NOS: 25-28), [Arg^{34}] (SEQ ID NOS: 29-32), [$Arg^{26,34}$] (SEQ ID NOS: 33-36), [Lys^{36}] (SEQ ID NOS: 37-40), [Arg^{26}, Lys^{36}] (SEQ ID NOS: 41-44), [Arg^{34}, Lys^{36}] (SEQ ID NOS: 45-46), [D-Lys^{36}], [Arg^{36}] (SEQ ID NOS: 37-40), [D-Arg^{36}], [$Arg^{26,34}$, Lys^{36}] (SEQ ID NOS: 49-52), or [$Arg^{26,36}$, Lys^{34}] (SEQ ID NOS: 25-28);

(b) [Asp^{21}] (SEQ ID NOS: 53-56);

(c) at least one of [Aib^8] (SEQ ID NOS: 57-60), [D-Ala^8] and [Asp^9] (SEQ ID NOS: 61-64); and

(d) [Tyr^7] (SEQ ID NOS: 65-68), [N-acyl-His^7] (SEQ ID NOS: 69-72), [N-alkyl-His^7] (SEQ ID NOS: 73-76), [N-acyl-D-His^7] or [N-alkyl-D-His^7];

(v) a compound of formula (I) is not a combination of any two of the substitutions listed in groups (a) to (d); and

(vi) a compound of formula (I) is not [N-Me-Ala^8]hGLP-1(8-36 or -37) (SEQ ID NOS: 77, 78), [Glu^{15}]hGLP-1(7-36 or -37) (SEQ ID NOS: 79, 80), [Asp^{21}]hGLP-1(7-36 or -37) (SEQ ID NOS: 53, 54) or [Phe^{31}]hGLP-1(7-36 or -37) (SEQ ID NOS: 81, 82).

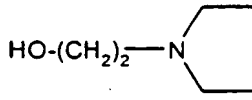
2. A compound according to claim 1 or a pharmaceutically acceptable salt thereof wherein A^{11} is Thr; A^{13} is Thr; A^{14} is Ser, Aib or Ala; A^{17} is Ser, Ala, Aib or D-Ala; A^{18} is Ser, Ala, Aib or D-Ala; A^{21} is Glu or Ala; A^{23} is Gln, Glu, or Ala; and A^{27} is Glu or Ala.

3. A compound according to claim 2 or a pharmaceutically acceptable salt thereof wherein A^9 is Glu, N-Me-Glu or N-Me-Asp; A^{12} is Phe, Acc or Aic; A^{16} is Val, D-Val, Acc, Aib, Ala, Tle or D-Ala; A^{19} is Tyr, 3-Pal, 4-Pal or D-Tyr; A^{20} is Leu, Acc, Cha, Ala or Tle; A^{24} is Ala, Aib or Acc; A^{25} is Ala, Aib, Acc, Lys, Arg, hArg, Orn, HN-CH($(CH_2)_n$-NH-R^{10})-C(O); A^{28} is Phe or Ala; A^{29} is Ile, Acc or Tle; A^{30} is Ala, Aib or deleted; A^{31} is Trp, Ala, 3-Pal, 4-Pal or deleted; A^{32} is Leu, Acc, Cha, Ala or deleted; A^{33} is Val, Acc, Ala, Gaba, Tle or deleted.

4. A compound according to claim 3 or a pharmaceutically acceptable salt thereof wherein A^8 is Ala, D-Ala, Aib, A6c, A5c, N-Me-Ala, N-Me-D-Ala or N-Me-Gly; A^{10} is Gly, Ala, D-Ala or Phe; A^{12} is Phe, A6c or A5c; A^{16} is Val, Ala, Tle, A6c, A5c or D-Val; A^{20} is Leu, A6c, A5c, Cha, Ala or Tle; A^{22} is Gly, Aib, β-Ala, L-Ala or D-Ala; A^{24} is Ala or Aib; A^{29} is Ile, A6c, A5c or Tle; A^{32} is Leu, A6c, A5c, Cha, Ala or deleted; A^{33} is Val, A6c, A5c, Ala, Gaba, Tle or deleted.

5. A compound according to claim 4 or a pharmaceutically acceptable salt thereof wherein R^1 is OH or NH_2.

6. A compound according to claim 5 or a pharmaceutically acceptable salt thereof wherein R^2 is H and R^3 is (C_1-C_{30})alkyl, (C_2-C_{30})alkenyl, (C_1-C_{30})acyl,



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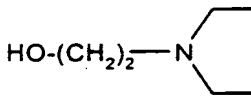
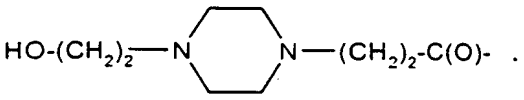


or



7. A compound according to claim 1 wherein said compound is

[D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]-GLP-1(7-34)NH_2;

[D-Ala^{8,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2;

[Ala^{18,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 83);

[Ala^{16,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 84);

[Ala^{14,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 85);

[Ala^{22,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 86);

[Hppa^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 87);

[Ala^{15,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 88);

[Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-35)-NH_2 (SEQ ID NO: 89);

[Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 90);

[Ala^{15,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 91);

[Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 92);

[Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 93);

[Ala^{21,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 94);

[Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 95);

[Ala^{22,23,27,32}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 96);

[Ala^{22,23,26,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 97);

[Ala^{22,23,27,31}, 3-Pal^{19}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 98);

[Ala^{22,23,27,28}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 99);

[Ala^{22,23,27,29}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 100);

[Ala^{23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 101);

[Ala^{20,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 102);

[Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 103);

[Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 104);

[D-Ala^{10}, Ala^{22,23,27}, 3-Pal^{19,31}, Gaba^{33}]hGLP-1(7-33)-NH_2;

[D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2;

[Ala^{17,23,27}, 3-Pal^{19,26,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 105);

[D-Ala^{8}, Ala^{17}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2;

[Ala^{17,23,27}, 3-Pal^{19,31}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 106);

[D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{29}]hGLP-1(7-34)-NH_2;

[D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{16}]hGLP-1(7-34)-NH_2;
[D-Ala^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2;
[D-Ala^{22}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2;
[Aib^{8}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 107);
[D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2;
[Aib^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 108);
[Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 109);
[Ala^{17,23,27}, 3-Pal^{19,31}, Tle^{33}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 110);
[Tle^{16}, Ala^{17,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 111);
[N-Me-D-Ala^{8}, Ala^{17,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2;
[Aib^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}]hGLP-1(7-33)-NH_2 (SEQ ID NO: 112);
[Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16,20}, Gaba^{34}]hGLP-1(7-34)-NH_2 (SEQ ID NO: 113);
[D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Tle^{16}, Gaba^{34}]hGLP-1(7-34)-NH_2;
[D-Ala^{8,22}, Ala^{17,18,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2;
[D-Ala^{8,18}, Ala^{17,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2;
[D-Ala^{8,17}, Ala^{18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; or
[D-Ala^{8}, Ala^{17,18,22,23,27}, 3-Pal^{19,31}, Gaba^{34}]hGLP-1(7-34)-NH_2; or a pharmaceutically acceptable salt thereof.

8. A compound according to claim 1 wherein said compound is
[Aib^{8}, A6c^{32}]hGLP-1(7-36)NH_2 (SEQ ID NO: 114);
[A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 115);
[Aib^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 116);
[(Tma-His)^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 117);
[A6c^{8}]hGLP-1(8-36)-NH_2 (SEQ ID NO: 118);
[A6c^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 119);
[A6c^{16,20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 120);
[A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 121);
[A6c^{20}, Aib^{24}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 122);
[Aib^{24}, A6c^{29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 123);
[A6c^{16,29,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 124);
[Ura^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 125);
[Paa^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 126);
[Pta^{7}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 127);
[N-Me-Ala^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 128);

[N-Me-Ala^{8}]hGLP-1(8-36)-NH_2 (SEQ ID NO:);
[N-Me-D-Ala^{8}]hGLP-1(7-36)-NH_2;
[N-Me-D-Ala^{8}]hGLP-1(8-36)-NH_2;
[N-Me-Gly^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 129);
[A5c^{8}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 130) ;
[N-Me-Glu^{9}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 131);
[A5c^{8}, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 132);
[Aib^{8}, A6c^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 133);
[Aib^{8,25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 134);
[Aib^{8,24}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 135);
[Aib^{8,30}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 136);
[Aib^{8}, Cha^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 137);
[Aib^{8}, Cha^{32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 138);
[Aib^{8}, Glu^{23}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 139);
[Aib^{8}, A6c^{20}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 140);
[Aib^{8}, A6c^{20,32}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 141);
[Aib^{8,22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 142);
[Aib^{8},β-Ala^{22}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 143);
[Aib^{8}, Lys^{25}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 144);
[Aib^{8}, A6c^{12}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 145);
[Aib^{8}, A6c^{29}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 146);
[Aib^{8}, A6c^{33}]hGLP-1(7-36)-NH_2 (SEQ ID NO: 147);
[Aib^{8,14}]hGLP-1(7-36)NH_2 (SEQ ID NO: 148);
[Aib^{8,18}]hGLP-1(7-36)NH_2 (SEQ ID NO: 149);
[Aib^{8,17}]hGLP-1(7-36)NH_2 (SEQ ID NO: 150); or
[Aib^{8}, D-Arg;^{26}]hGLP-1(7-36)NH_2; or a pharmaceutically acceptable salt thereof.

9. A pharmaceutical composition comprising an effective amount of a compound according to claim 1 or a pharmaceutically acceptable salt thereof and a pharmaceutically acceptable carrier or diluent.

10. A method of eliciting an agonist effect from a GLP-1 receptor in a subject in need thereof which comprises administering to said subject an effective amount of a compound according to claim 1 or a pharmaceutically acceptable salt thereof.

11. A method of treating a disease selected from the group consisting of Type I diabetes, Type II diabetes, obesity, glucagonomas, secretory disorders of the airway, metabolic disorder, arthritis, osteoporosis, central nervous system disease, restenosis, neurodegenerative disease, renal failure, congestive heart failure, nephrotic syndrome, cirrhosis, pulmonary edema, and hypertension, in a subject in need thereof which comprises administering to said subject an effective amount of a compound according to claim 1 or a pharmaceutically acceptable salt thereof.

12. A method according to claim 11 wherein said disease is Type I diabetes or Type II diabetes.

INTERNATIONAL SEARCH REPORT

national Application No
PCT/US 99/28929

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C07K14/605 A61K38/26 A61P3/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C07K A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91 11457 A (BUCKLEY DOUGLAS I ;HABENER JOEL F (US); MALLORY JOANNE B (US); MOJ) 8 August 1991 (1991-08-08) claims; examples	1,2,9-12
X	EP 0 733 644 A (LILLY CO ELI) 25 September 1996 (1996-09-25) page 3, line 51 -page 4, line 1; claims; examples	1,2,9-12
X	WO 97 29180 A (BRODERICK CAROL L ;BORTS TRACY L (US); MILLER ANNE R (US); LILLY C) 14 August 1997 (1997-08-14) claims; examples	1,2,9-12
X	US 5 545 618 A (BUCKLEY DOUGLAS I ET AL) 13 August 1996 (1996-08-13) claims; figures 1,2A; examples	1,2,9-12

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2000	15/05/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Fuhr, C

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INTERNATIONAL SEARCH REPORT

national Application No
PCT/US 99/28929

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	FR 2 777 283 A (ADIR) 15 October 1999 (1999-10-15) page 2, line 10 -page 6, line 3; claims; examples	1,2,9-12
A	WO 98 08871 A (NOVONORDISK AS ;KNUDSEN LISELOTTE BJERRE (DK); NIELSEN PER FRANKLI) 5 March 1998 (1998-03-05) claims; examples	1,9-12

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/ 28929

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Remark: Although claims 10-12 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

rnational Application No
PCT/US 99/28929

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9111457 A	08-08-1991	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		US 5545618 A	13-08-1996
EP 0733644 A	25-09-1996	US 5705483 A	06-01-1998
		AU 708159 B	29-07-1999
		AU 2026895 A	03-10-1996
		BR 9503036 A	23-09-1997
		CA 2150080 A	22-09-1996
		CN 1131674 A	25-09-1996
		CZ 9501321 A	16-10-1996
		FI 952536 A	22-09-1996
		HU 74729 A	28-02-1997
		JP 8269097 A	15-10-1996
		NO 952034 A	23-09-1996
		NZ 272186 A	29-01-1997
		PL 308783 A	30-09-1996
		US 5977071 A	02-11-1999
		ZA 9504141 A	22-11-1996
WO 9729180 A	14-08-1997	AU 2263197 A	28-08-1997
		CA 2243718 A	14-08-1997
		EP 0879279 A	25-11-1998
US 5545618 A	13-08-1996	AT 164852 T	15-04-1998
		CA 2073856 A	25-07-1991
		DE 69129226 D	14-05-1998
		DE 69129226 T	30-07-1998
		DK 512042 T	11-05-1998
		EP 0512042 A	11-11-1992
		ES 2113879 T	16-05-1998
		WO 9111457 A	08-08-1991
FR 2777283 A	15-10-1999	AU 2368899 A	21-10-1999
		CN 1232038 A	20-10-1999
		EP 0955314 A	10-11-1999
		HU 9900604 A	28-09-1999
		JP 11310597 A	09-11-1999
		NO 991199 A	11-10-1999
		NZ 334379 A	28-10-1999
		PL 331960 A	11-10-1999
WO 9808871 A	05-03-1998	AU 3847897 A	19-03-1998
		AU 4112497 A	19-03-1998
		CN 1232470 A	20-10-1999
		CZ 9900629 A	14-07-1999
		WO 9808872 A	05-03-1998
		EP 0944648 A	29-09-1999
		EP 0929576 A	21-07-1999
		JP 2000500505 T	18-01-2000
		NO 990950 A	28-04-1999
		PL 331896 A	16-08-1999